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DEFENSE RDT&E PLANNING AND STRATEGY PARAMETERS: METHODOLOGICAL CONSIDERATIONS

Appendices

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This report consists of input papers prepared to further analysis involved in one element of a research program for the Advanced Research Projects Agency concerned with the development of RDT&E planning and strategy parameters. These papers include discussions of defense planning guidelines as well as a description of the formal RDT&E system and an analysis of defense RDT&E policies, objectives, and constraining factors.

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This Technical Note is in partial fulfillment of Contract DAHC15-73-C-0183.

FOREWORD

This report consists of a series of input papers (presented as Appendices A through E) which were prepared to further the analysis involved in one element of a research program for the Defense Advanced Research Projects Agency (ARPA) concerned with the development of RDT&E planning and strategy parameters. The study is concerned with an analysis of the international and domestic trends which impact upon future defense planning and the introduction of appropriate goals and guidelines to stimulate the RDT&E planning process.

The input papers presented here include discussions of defense planning guidelines, a description of the formal DOD RDT&E system, defense RDT&E policies and objectives, and RDT&E constraining factors.

The Project Leader was Ronald C. Wakeford, who was supported in the research effort by William W. Perry (Consultant), John C. Scharfen, and Hazel T. Ellis as well as other staff members and consultants of the SSC.

Richard B. Foster
Director
Strategic Studies Center

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SUMMARY

The purpose of this Appendix is to identify significant trends for the next decade which impact on the security of the United States and to derive from those trends defense planning goals and guidelines for the generation of future military forces. The principal trends identified in this Appendix which will impact on U.S. national security for the next decade are:

- Continued decline of bipolarity and increased polycentrism with two superpowers, the U.S. and USSR, still predominant.
- Increased interdependence of proliferating nations generated by economic, agricultural and ecological concerns.
- Increasing gap between have and have-not nations.
- Rise of international organizations with change in concepts of national sovereignty.
- Nuclear proliferation, piracy, blackmail.
- Rapid depletion of resources.
- Durability and integrity of Warsaw Pact, continued Sino-Soviet split and evolving strength of China.
- Continued decline of appeal of international communism.
- Continued prevalence of revolutionary wars within less developed countries.
- Increased emphasis on arms control and continued limitations on the use of force to resolve conflict.
- Increased but unstable U.S.-Chinese relations and some Japanese-Chinese economic interdependence.
- Continued world population growth. However, zero population growth in the United States promoting a future gerontocracy.
- Increasing world urbanization, with parallel concern for human rights and rising national expectations.
- Loosening of NATO military ties with greater economic and cultural cohesion.

- Japanese independence from the United States. Japanese development of naval forces and tacit leadership of West Pacific and Asia.
- Continued UN impotence in crisis and conflict.
- Fewer formal U.S. military commitments, reduction of U.S. forces in Europe (through MBFR) and Asia with Europe continuing as first priority after defense of U.S.
- Continued U.S. involvement and leadership in broad range of world affairs with greater reliance upon allies and continued military assistance through grants and sales.
- Continuing growth of Soviet seapower.
- Spiraling costs of U.S. military forces and a reduced manpower base.
- Changing concepts of strategy and tactics through impact of computer, lasers, small energy packs and instant communications.
- Increased importance of space, oceans and seabed.
- Continued U.S. and allied dependence on sea and air LOCs for economic well being and defense.
- Continued Soviet emphasis on armor and blitzkrieg in Central Europe.
- Marginal Soviet capability to project force into forward areas.

The principal defense planning guidelines proposed in this module for the next decade are:

- Through the foreseeable future, the overall objective of U.S. security policy will remain defensive, devoted to institutional stability and world social progress as opposed to territorial acquisition, world anarchy, and social recidivism. Deterrence of any armed conflict or psychological or political aggression will continue to dominate national strategy. The U.S. declaratory policies and the perception of U.S. total strength are, therefore, equally as significant and effective as operational strategies and effective military strength.
  - All national strategic initiatives and declarations must be made with due concern for all the aspects of national strategy, political, psychological, economic, military, technological and social.
  - The success of deterrence makes possible the pursuit of a better state of peace, and all plans and programs should, as a secondary concern, promote this objective. The primary concern is deterrence.
  - Deterrence is achieved through strength and a successful communication of that strength to allies and potential adversaries.

- Deterrent strength is derived from the sum total of U.S. national institutions as augmented by allies. The challenge in maintaining deterrent strength is:
  - -- to promote and maintain national resolve through dynamic leadership
  - -- to allocate limited U.S. resources to national institutions and allies in such manner that maximum deterrent benefit is derived
  - -- to limit commitments to achievable and essential objectives
  - -- to solicit from allies resources essential for defense.
- Effective communication of strength relies upon:
  - -- a coherent declaratory policy coordinated throughout the national level of government and within defensive alliances
  - -- the manifestation of the physical attributes of strength through military exercises, demonstrations and deployments
  - -- the manifestation of national resolve.

• Priority to be assigned to intelligence efforts which promote a better understanding of adversarial and allied intentions, perceptions and capabilities.
  - Scientific efforts to bridging cultural gaps to promote understanding
  - Centralized technical information processing interpreting and distribution systems
  - Scientific approach to net technical assessments.

• Priority to understanding U.S. systems, limitations, and vulnerabilities.
  - Improved, integrated operational test and evaluation systems.

• Over the next decade priority should be assigned to creating and maintaining:
  - Sufficient strategic nuclear strength to deter the use of nuclear force against the United States, its forces or allies
  - Sufficient conventional strength in NATO Europe to deter conventional aggression, to contain a blitzkrieg assault, to interdict enemy reinforcement and provide continuous close air support.
  - Modestly manned, highly modernized, dual capable, mobile, fully trained general purpose forces with a capability to be deployed or redeployed globally to engage in diverse levels and natures of conflict less than global war.
  - An expanding, objective oriented technology base to guard against technological surprise and to provide capabilities for U.S. forces which will maximize relative strengths and compensate for relative weakness.
  - Positive strategic control to include improved command, control and communications.
  - Strategic and tactical mobility.

- A strategy which accommodates flexible options as described in Secretary of Defense Schlesinger's testimony for the FY75 budget will dominate at least the early part of the next decade.

  - The national strategic target attack policy must be drafted to direct planning and targeting to support flexible options.
  - The national strategic nuclear declaratory policy must provide for the communication of a willingness for the U.S. to accept a policy for controlled conflict. A symmetrical U.S.-USSR relationship of strategies where both sides demonstrate such a commitment is feasible. An asymmetrical strategy where one of the potential adversaries opts only for assured destruction is probably not feasible. The precept implies a communion of intent between adversaries which is adequately communicated and verified by demonstrable initiatives.
  - Symmetrical strategies require relatively symmetrical capabilities. This precept introduces the concept of equivalency into the definition of nuclear sufficiency.
  - Nuclear strategy must be implemented in such a manner that it:

    - maximizes the U.S. potential for survival in strategic nuclear war
    - seeks termination of conflict as early as possible on terms not unfavorable to the U.S. and its allies
    - promotes and abets the U.S. position in arms control and disarmament negotiations such as SALT
    - promotes positive strategic control.

- U.S. national strategy must be implemented in such manner that modestly manned general purpose forces retain the capability to meet global commitments at least to the simultaneously prosecuted 1 1/2 war in more than one theater conceptual requirements. This requirement can be achieved by:

  - Increasing the capability to project force into areas of vital interest

    - deployed forces must be redeployable. They must not be so dedicated to or entrenched in a limited area that redeployment is inhibited. Avenues of egress must not be unduly constrained
    - forward and intermediary staging and refueling aerial ports must be guaranteed

    - deployment planning which integrates the efforts of the transportation operating agencies, the Services, the JCS, the unified commander and his subordinates must be standardized
    - continued emphasis must be given to strategic transport, forward deployed equipment and supplies, reception facilities and intra theater transport
    - priorities for defense of sea and air lines of communication must be established for operations during periods of conflict. Defensive planning must include security of terminals such as sea and aerial ports.

- Preparing to defend in new areas of operations to include:

  -- defense of equipment and facilities in space
  -- defense of sea based surface and undersurface commercial and military complexes.

- Capitalizing on the strength of allies in collective security arrangements. If an ally's strength lies in manpower, geography, economic wealth or technology, defensive concepts should emphasize these strengths with the United States and other allies augmenting where required.

  -- U.S. assistance programs and equipment should be tailored to the requirements of the allies
  -- collective security and military assistance programs must be pursued with discretion to insure that U.S. assistance does not promote instability or aggression in an area of vital interest which would be damaging to U.S. interests
  -- emphasize joint allied defense planning, cooperative weapon and RDT&E programs.

- Capitalizing on an appreciation for the strategy of time. National security measures must buy sufficient time to permit an orderly evolution of the world social order to better states of peace and permit adversary ideologies time to accommodate, change or perish.

- Properly rationalizing the dichotomies of the: short war--long war, ready force--mobilization base, deterrence--war fighting, mobility--forward deployment, total force--autarkic, high nuclear threshold--low threshold. In rationalizing these dichotomies recognize that they are highly interdependent and that U.S. strategic concepts must remain flexible and not be tyrannized by labels or technical paradigms. With these reservations emphasis for planning and programming should be based on:

  -- wars of limited duration to be fought by ready forces forward deployed where freedom of action and a redeployment capability is retained
  -- the anticipation of a mutually acceptable MBFR which will permit redeployment of U.S. forces from Central Europe, leaving a modest but elite, professional force without degrading the overall defense of NATO Europe
  -- a reliance upon allied forces to provide requisite resources for defense
  -- increased international violence from paranational organizations such as the Palestine Liberation Movement
  -- a relatively ambiguous declaratory policy on nuclear thresholds which, nevertheless, complements a strategy for wars of limited duration
  -- a relatively unambiguous operational policy for nuclear thresholds based on detailed analysis of consequences at various levels of employment.

- Developing strategic concepts which provide sufficient latitude to capitalize on technology to generate capabilities which maximize force potential on a modest military manpower base.

- The question of how much is enough is answered by: how much do our potential adversaries have, how much will they have, what are their intentions for using their power against us and how resolute are their intentions when faced with a determined defense.
  - U.S. forces should be structured as a counterforce to adversary forces not as a mirror image.
  - U.S. forces should be structured to provide the highest degree of ready force visibility as an essential element of deterrence and short war fighting capability. Funding for the maintenance of such ready forces may have to be supported from the mobilization base.
  - U.S. forces should be structured so as to facilitate ability to absorb technology as easily and quickly as possible.
  - Technology should be directed to providing low cost, simple systems, easily employed and easily maintained or which can be economically discarded.
  - Forces should be organized to make the most effective use of manpower. The all-volunteer force is currently a political and perhaps a cultural imperative. The concept of a mass army served by conscription is incompatible with current U.S. political and social realities. The all-volunteer force symbolizes the end of an epoch and there are no obvious signs of any possibility for turning back in this decade.
    - the U.S. must anticipate that NATO allies will move toward similar all-volunteer armies or to a militia system. A strong militia system appears preferable for the defense of Europe
    - recruiting, training and retention programs should be given priority call on resources. Recruiting for initial input of qualified personnel, retention to increase professionalism and decrease recruit requirements and training to provide the most effective use of limited forces
    - manpower considerations reinforce the necessity to structure and plan for wars of limited duration. Strategic concepts must reinforce the short war philosophy
    - reconvene the Key West, Newport, Rhode Island Conferences of 1948 to reevaluate ways to eliminate wasteful, inefficient and duplicative systems and organizations within the Services
    - revise the Unified Command Plan to eliminate and cadre area headquarters
    - anticipate that a shrinking manpower base of military age will, by 1980, make retention of current force levels extremely difficult in an all-volunteer force.
  - Minimize resource requirements and impact upon economy
  - Improve management techniques to enhance program efficiency and provide reduced acquisition costs

-- continue and expand design-to-cost program
-- pursue further prototyping and "fly before buy" programs
-- program selectivity based on effectiveness and "return on investment" concept
-- exploit competitive procurement techniques
-- professional program management

- Integrate planning with appropriate sectors of the defense supporting economy.

I INTRODUCTION

This appendix to the RDT&E parameters study is designed to identify significant trends which impact on the security of the United States and to derive from those trends defense planning guidelines for the generation of future military forces. The timespan of this study -- a decade -- is modest, which should facilitate our effort.

Chapters II and III are devoted to the identification and discussion of these trends. The evolution of Soviet strategy is believed to merit special discussion and is therefore treated separately in Chapter IV. Chapter V provides findings on defense planning goals and guidelines.

It has become commonplace to cite the rapid acceleration of change within the world, the geometric growth of knowledge, and the impact of science and technology feeding upon the increasing base of its own creation. Commonplace or not, it seems essential to recognize that the implications of this rapid change bode disaster as well as progress, and new brands of ignorance as well as the expansion of knowledge. In mid-1974, there is widespread famine in Africa, the pentagonal nuclear club has become hexagonal with India exploding a nuclear device, the energy crisis has erupted and the potential for ecological disaster is increasing daily. The very significant consequences of these events is that each impacts substantially on the United States. The United States is so entrenched, so involved in the affairs of the world that it is impossible to isolate it from famine in India or fratricide in Africa. While from some quarters it might be viewed as a tempting alternative, the United States cannot opt out of all the responsibilities which have been shouldered since 1945. For the ten-year timespan of this study, there will be a continued, intimate U.S. involvement in the problems of the world.

Because of this continued involvement, there are many diverse and unusual considerations which will impact on the security of the United States. In identifying critical trends for the purpose of generating defense guidelines this appendix will, of necessity, be selective and will not cover all eventualities. An attempt will be made to isolate

and discuss only those trends which are most critical and most meaningful to this effort.

II TRENDS AND IMPLICATIONS: POLITICAL, MILITARY, AND ECONOMIC

Forecasting

A number of systems have been developed for forecasting the future in a systematic manner.[1] The Delphi method, which is basically a reiterative process for seeking expert consensus, is well known. A quantitative, analytical approach developed in Germany (which projects the expectation that China will be the dominant world power in the Twenty-first Century) has gained wide acceptance in Europe. The Kahn-Wiener speculative approach for predicting into the year 2000 is less systematic and more conjectural, and is based upon creating scenarios and alternative futures. A fourth system is the time series analysis in which events are evaluated and normally quantified using complex mathematical approaches at regular time intervals to derive trends from the past to project into the future.

In this appendix, trends are identified based on an extensive research of applicable literature and the expertise of an experienced interdisciplinary staff. The method is eclectic and closer to the Delphi and Kahn-Wiener approach than to the European and time-series systems. The short-term trends which are identified are heuristic and applicable to a wide range of judgments which follow on defense guidelines and, ultimately, RDT&E parameters for supporting those guidelines.

The trends which are identified below are divided into categories of national security considerations for convenience and to facilitate interpretation. They are arbitrary and many trends could fit under more than one category. They are also highly interdependent and each interacts on all others. The taxonomy is not intended to represent the elements of national security as being compatible to a simple formula of independent, discrete variables.

World Order

It seems inconceivable that within the next ten years there will be any substantial change in the nation-state system. There could be a nuclear

[1] Rudolph Klein, "Limiting Growth," Congressional Record, 6 June 1974 p. S9891.

or natural catastrophe which could substantially affect the world as we know it. However, there is no reason to believe that even under these circumstances, the nation-state system would not survive. The chances appear good that the world order of 1985 will more closely resemble the order of 1950 than it will the order of 2000 -- that is, any change which takes place will more likely occur in the last decade of the century than in the next. While ample instability and trauma are evident in the world of 1974, there are no substantial movements or programs visible which are fostering basic institutional change. If such forces are to be created, they will need more than a single decade of nourishment and growth before they can impact on an order as firmly established and so taken for granted as a natural condition as is the nation-state system.

Within the framework of the nation-state system there are many visible trends. The observation that the system is evolving toward multi- rather than bipolarity has become axiomatic. The Indian explosion of a nuclear device reinforces this perception of evolution to multipolarity. This trend in the short term seems certain although reversible in the long term. Even in the short term, the trend will probably not be inexorable. U.S.-USSR negotiations, for example, could, through the relaxation of tension, gain more freedom for the superpowers which would give them more relative political or economic power vis-a-vis the other nations of the world. The net effect could be to reinforce bipolarity. The extreme of such potential is the European fear of a possible condominium of power. The possibility of nuclear proliferation extending to Japan, Iran or even Pakistan (possibly as a surrogate of China) is increased substantially with the Indian nuclear explosion. Given the symbolism of nuclear power in national perspectives such proliferation would accelerate multipolarity.

Notwithstanding the trend to multipolarity, the United States and USSR are still the dominant actors on the international stage and undoubtedly will be through 1985. The economic integration of Western Europe should continue through the decade although there are no signs of political integration over this short term. The economic cohesion in Europe would have a discernible impact on the world. It would foster multipolarity, would

encourage less dependence on and identification with the United States as the focus of Western power and could encourage a move toward a continental, East-West European detente. The CSCE (Conference on the Security and Cooperation in Europe), if it lives up to Soviet expectations, could foster this one-Europe concept which could strengthen the Soviet position as a Eurasian power while tending to isolate the United States.

Japan's spectacular economic growth is well documented. The resource crisis may slow this growth; however, at least in the next decade, it seems that the momentum of Japanese progress will carry it through. The Japanese trade initiatives with China should begin to bear fruit although the economic intercourse is likely to prove frustrating to Japan due to Chinese unpredictability and calculated intransigence. A Sino-Japanese confluence is likely to have more impact on the world than improved Russo-Japanese relations. By the end of the next decade the Japanese self defense force should have grown substantially and the Japanese fleet will be close to developing a capability to secure the sea lines of communication at least into and from the Indian Ocean. Over the long run it is probable that Japan will again assume the position of the dominant naval power in the Western Pacific.

After more than twenty-five years of Soviet hegemony in the Warsaw Pact area there are no short-term signs of that Pact breaking up. The occupation of Czechoslovakia serves as a stark reminder of the Soviet determination to maintain the integrity of the East European bloc. If there is change in the next decade, it will be barely perceptible and will be motivated more by economic than political considerations, more by the search for a better life than nationalism and more by the erosion of established barriers than by force of arms or the threat of force.

The biggest question mark in the next decade is what to expect from China after Mao. As of this writing Chairman Mao Tse-tung is 81 years old, Premier Chou En-Lai is 76. The possibility of Mao's surviving the decade is not good. Should there be an orderly transition of power upon his death and an extension of current Chinese policy, China should have limited impact on the evolving structure of world order. Should there be a traumatic struggle for power it could lead to chaos and internal disintegration of

the Chinese state. However, it is more likely that in crisis China would turn inward, isolate itself from the world, and devote its energies to sorting out its problems. Over the long run the chances seem good that China will dominate Asia. Over the short run of the next decade, with or without the death of Mao and with either an orderly or disorderly transfer of power, the Chinese are unlikely to be the focus of concern for world stability. The Chinese military threat is not acute. If they are capable of pressing their borders further to the South, into the Pacific or against India, they seem disinclined to do so. The Sino-Soviet split has changed the perception of the Chinese threat. There are real military as well as political restraints which are imposed upon China by virtue of its disaffection with the Soviets. There seems to be no indication that the death of Mao will heal this breach even though the Soviets seem to be awaiting the departure of Mao before making serious overtures to healing the breach. Within fifteen years the Chinese intercontinental ballistic missile nuclear capability will probably be a serious threat to the United States and the USSR to the extent that it will change basic concepts of U.S. strategy, but such will probably not eventuate in ten years. U.S.-Chinese relations are tenuous. They are built more upon mutual expediency than confidence. Peking appears to be extremely suspicious of U.S. motives and the potential for a U.S.-USSR concord (both of whom are considered to be imperialist powers) which would be a threat to Chinese interests. On the other hand, the recent U.S.-Chinese thaw has permitted an increase in trade from a five million dollar level in 1971 to a one billion current flow making the United States the second largest trading partner with China (Japan being the first in volume). The balance of trade is substantially in favor of the United States and the Chinese do not, at this time, enjoy a favored nation status.[1] There appear to be sound economic as well as political reasons for the United States to continue to encourage these improved relations with the Chinese. At this time, however, the communion of interest appears to be weak and will require heroic but patient diplomacy by the United States if continued good relations are to survive.

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[1] J. F. Ter Horst, Detroit News, p. 7, 2 June 1974.

In the last decade we were witness to the final death throes of the image of the cohesion of an International Communist Movement. Soviet confidence in the inevitability of the ascendancy of the Marxist-Leninist system does not seem to be shaken. However, the image appears to have suffered badly throughout the rest of the world. The lack of credibility of a universal communist system has lessened the tension between the United States and USSR in the less developed areas of the world and, through the next decade, there seems little prospect that the ideal of the International Communist Movement will be disinterred.

The proliferation of nations has drastically changed our view of the world order. When the United Nations came into formal existence with the USSR deposit of its ratification in October of 1945 there were only 29 members of that organization. There seems no adequate group description for those non-European, non-industrialized nations which make up the bulk of the more than 135 nations which are currently recognized in the United Nations. "Less developed countries" implies a paucity of resources that is certainly not true in the case of Saudi Arabia, Kuwait, Qatar and Libya. The "unaligned Third World" is neither unaligned nor is it the entity the term connotes. Whatever we choose to call the remainder of the world, it will continue to be a source of instability. Over the next decade the industrialized nations (even with energy and other resource problems) and a few resource wealthy nations will continue to be the "have" nations while the remainder of the world will be the "have nots." Even with a continued two percent growth in world population per annum there should be progress in eliminating some famine, pestilence and disease in the less fortunate nations in the next decade. However, the disparity between the haves and the have nots will continue to grow. While there should be a real improvement in the standard of living in these impoverished areas, the difference between the standards of two worlds will, with better communication and more awareness, be more readily perceived. This greater perception of the difference between expectations and the prospects for achieving them will probably generate more frustration and dissatisfaction than have the actual realities of their impoverished condition. These are the newer nations of the world and they have great capacity for extreme

nationalism, local war across boundaries, civil war and insurgency, xenophobia, fratricide, and despotism. They are a principal source of instability and the chief potential for local wars.

In the long run, there will probably be more evidence of multipolarity. Brazil should play a bigger role in Latin America, Indonesia should become more influential in Southeast Asia, Europe should become more cohesive, Japan should extend its influence in Korea and the Western Pacific. In the short run of ten years the United States and USSR should remain the dominant players on the international scene. This means that the United States will continue to shoulder substantial international responsibilities. How does this view impact on defense planning guidelines? If world order were the only consideration (which it is not) and given this very brief view of the world in 1975, the United States should, through the next ten years, maintain a defense posture which not only deters aggression against the United States and its allies but which permits a freedom to exercise requisite political, economic, psychological and, where necessary, military initiatives in areas of critical interest. In brief, its defense posture should support the United States in a role as one of the two dominant powers in a world emerging from but not free of the consequences of bipolarity. In more detail, defense planning guidelines based on this view of world order should provide for:

- A broader view of net assessments, capabilities planning and analyses of potential areas of conflict to reorient from almost an exclusive focus on the Soviet Union as the center of adversarial initiatives to wider, more catholic perspectives of agression.
- An awareness of the increased potential for localized conflict in areas which:
  - Do not vitally affect U.S. security interests
  - Warrant U.S. detachment rather than involvement
  - Require sufficient U.S. capability to warn off intervention by other parties when their intervention would be inimical to U.S. interests
- A reappraisal of the realities of the defense of Europe which recognizes the trend toward a more integrated and independent Western Europe seeking more equal partnership in the Atlantic Alliance.

- Maintaining a visible U.S. commitment and, in vital areas, a military presence to bolster the confidence of our allies and to serve as a warning to potential adversaries that:
  - No country or coalition will be permitted to establish a world-wide suzerainty
  - Regional dominance inimical to the interests of the United States will be resisted.
- Maintaining a capability to deploy military forces to those vital areas where a continued presence is either impractical or undesirable.
- The recognition that it would be unnatural for Japan to continue to repudiate projection of naval power throughout the Western Pacific through this century.
- A realization that greater opportunities exist for communicating with potential adversaries but that such communications may require:
  - More involvement of the Soviet Union as a third party in what would formerly have been bilateral intercourse
  - Coordination between Soviet and U.S. military forces in common efforts in areas remote from either national base
  - More political terminals with the loosening of alliances and the tendency for nations to communicate with greater freedom.
- A technologically advanced strategic nuclear force of sufficient capability to:
  - Deter the Soviet Union from initiating strategic nuclear war or controlled intercontinental nuclear war
  - Reassure allies of U.S. determination
  - Encourage meaningful arms control negotiations
  - Provide flexibility in targeting options to support a range of strategies.
- A readiness for more peace-keeping commitments which requires smaller, austere, mobile forces trained and equipped to provide a high order of relief to and control of a civil populace.

External Commitments

> Europe has a set of primary interests, which to us have none, or a very remote relation. Hence she must be engaged in frequent controversies, the causes of which are essentially foreign to our concerns. Hence, therefore, it would be unwise in us to implicate ourselves, by artificialities, in the ordinary vicissitudes of her politics, or the ordinary combinations and collisions of her friendship or enemies.
>
> -Washington's Farewell Address, 1796

Jurisdiction over the execution of U.S. foreign commitments is and has been a matter of controversy between the Executive and Legislative branches of government. The term "national commitment" has been given a rather narrow definition by the Senate in that it has prescribed, by resolution, that such results "only from affirmative action taken by the executive and legislative branches of the United States government by means of a treaty, statute, or concurrent resolution of both Houses of Congress . . ."[1] Historically, the term has included a much broader scope to include executive agreements, declarations, news releases, and even toasts[2] at official functions. Without joining the controversy, we will use the broader, historical sense of commitment in discussing current and future military obligations of the United States.

U.S. commitments are critical in formulating defense planning guidelines. They could dictate where and alongside whom the next war may be fought or with whom intercession may be joined. Commitments must also be considered if one is to apply and exercise the total force concept. The following questions will be addressed in this section:

- What has been the pattern of U.S. national security commitments?
- What will be the impact of U.S. national military commitments on defense planning guidance for the next decade?

The number of countries to which the United States is formally committed for defense is most commonly cited as 42. If Cuba (now excluded from the provisions of the Rio Pact) is included, the number would be 43. These members do not include the other 134 members of the United Nations to whom the United States is committed. However, this is a very tenuous commitment within the UN Charter to provide forces to the Security Council on its call "for the purpose of maintaining international peace and security."[3] The number of commitments might be extended even further if one

[1]U.S. Senate Resolution 85, 25 June 1969.

[2]Remarks of President Johnson during exchange of toasts with President Shazar of Israel, 2 August 1966.

[3]Charter of the United Nations, Article 43, 26 June 1945 (entered into force for the United States 24 October 1945)

included certain executive agreements with Spain, Iran, Liberia, Ethiopia, Morocco, Bahrain, Kuwait, Saudi Arabia, etc., which relate to bases and broad considerations of intention relating to defense. The scope of commitments in these treaties and other agreements ranges from very positive statements of obligation and intent such as:

- Berlin - "The NATO shield was long ago extended to cover West Berlin, and we have given our word that an attack in that city will be regarded as an attack upon us all."[1]

- NATO - "The Parties agree that an armed attack against one or more of them in Europe or North America shall be considered an attack against them all . . ."[2]

to very general statements of obligation and intent as in the following:

- Spain - "The United States government reaffirms its recognition of the importance of Spain to the security . . . of the Atlantic and Mediterranean areas. . . .A threat to either country . . .would be a matter of common concern to both countries. . . ."[3]

- Liberia - "In the event of aggression or threat of aggression against Liberia, the government of the United States of America and the government of Liberia will immediately determine what action may be appropriate."[4]

The bulk of current U.S. commitments are derived from multilateral treaties and specifically from the NATO Treaty (with 15 participating nations), SEATO (with 7)[5] and the Rio Treaty (with 20). If the definition of commitment

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[1]John F. Kennedy, President of the United States, statement regarding Berlin, in address to the Nation, 25 July 1961.

[2]The North Atlantic Treaty, Washington, D.C., 4 April 1949.

[3]Joint Declaration Concerning the Renewal of the Defense Agreement of 26 September 1953, United States/Spain, 26 September 1953.

[4]Agreement of Cooperation between the Government of the United States and the Government of Liberia, 8 July 1959.

[5]South Vietnam, Laos, and Cambodia are not signatories of SEATO but were included under the treaty's defensive provisions in protocol of the treaty. Cambodia has rejected the protection of SEATO. Laos has declared it will not "recognize the protection of any alliance or military coalition including SEATO" in the 1962 Geneva Declaration on the Neutrality of Laos. The United States and other nations agreed also in the Geneva Declaration to "respect the wish of . . .Laos not to recognize the protection of any alliance or military coalition, including SEATO."

is extended to other agreements, multilateral commitments are still dominant with the 135[1] nations committed to the United Nations. Not only is there a wide divergence in the degree of obligation and intent in the verbiage of U.S. treaties and commitments but there is also a broad scope of U.S. historical, economic, political and cultural identification with the various nations which either reinforces or deflates the degree of commitment. For example, the historical, economic, political and cultural ties of the United States to Great Britain tend to reinforce the U.S. commitment under the NATO Treaty while the relatively obscure relationship with Mauritius tends to dissipate the commitment given under the Charter of the United Nations.

It does not appear that treaties and agreements have been exceptionally reliable guides as to how nations view their commitments. The first U.S. alliance was executed with France in February of 1778. The Franco-American Treaty of alliance guaranteed the participants would defend the right of the American possessions of the other "mutually from the present time and <u>forever</u> against all other powers."[2] (Underscoring added.) Almost exactly five years later France declared war on England. The 1778 alliance bound the United States "forever" to assist French defense of the West Indies. While legalistically there was a U.S. imperative to provide military assistance to France, President Washington decided against such a course as it did not appear to be in the best national interests of the United States. France did not invoke the treaty because the United States, weak militarily, was of more value as a neutral which could supply food to France and the hard pressed West Indies.[3] Both France and the United States acted in national self-interest. In 1939, the USSR violated the Covenant of the League of Nations when it attacked Finland. Legalistically, France and Great Britain were obliged to redeem the covenant and

[1]As of 18 September 1973.

[2]Thomas A. Bailey, <u>A Diplomatic History of the American People</u>, p. 34 (New York, Appleton-Century-Crofts, Inc., 1958).

[3]Ibid, p. 84.

provide military assistance to Finland. To do so was not in their national interest as it would have found them simultaneously at war with both the Soviet Union and Germany. They did not redeem the covenant.

President Nixon set the tone for what appears to be a trend for U.S. policy relative to security commitments when he stated:

> . . .As far as commitments are concerned, the United States has a full plate. I first do not believe we should make new commitments around the world unless our national interests are very vitally involved. Secondly, I do not believe we should become involved in the quarrels of nations in other parts of the world unless we are asked to become involved and unless also we are vitally involved.[1]

While both the NATO and Warsaw Pact Alliances may lose some of their military cohesiveness they will undoubtedly still be effective coalitions of national power through the decade. Such organizations tend to adapt to the requirements of the period and survive. By 1985 NATO will probably be more oriented to concerns of economics, political affairs and science and less to military cooperation. U.S. commitments to England and Germany will probably be relatively strong and on the same order as those recognized today. U.S. commitments to other NATO nations will probably not be viewed as being as firm as in 1974 and certainly not as firm as in the 1950s. Associations with Italy, Greece and Turkey will likely be viewed in perspective of Meriterranean and Middle Eastern interests rather than in the context of NATO and the defense of Europe. Western dominance of the Mediterranean will probably be diminished and so will the ties between Italy, Turkey, Greece and the United States. The European states of the Northern Tier - Denmark and Norway - will, although not disassociating from NATO, pursue more neutral, nonaligned posture in day-to-day diplomacy and military policy. France will probably follow its current course of independence but will continue to assume a larger role in European affairs.

MBFR will undoubtedly produce mutual force redeployments out of the central sector of Europe as it appears to provide advantage to both the United States and USSR. 14 June of 1974 Leonid Brezhnev gave a clue to

[1]Richard M. Nixon in a 4 March 1969 news conference.

the Soviet predisposition when he said, "We think it is possible in the nearest future to achieve the first concrete results" on partial measures for a mutual reduction of forces. Undoubtedly the first reductions will be confidence builders. Should the experiment be successful, broader, more significant cuts will be made before the end of the decade. It is possible that by 1985 the United States could have as few forces as one division remaining in Central Europe. Much of the Soviet position will be based not on a quid pro quo with the United States but concerns much more fundamental to Soviet security -- the need for a continued Soviet presence in Eastern Europe to provide cohesiveness and backbone to the Warsaw Pact alliance and their perception of the threat on the Sino-Soviet borders.

The Organization of American States will also endure as a useful institution for the coordination of hemispheric policy and interstate affairs. However it, like NATO, will probably be less cohesive, less monolithic and less homogeneous. Brazil should begin to start exercising a more dominant role in the hemisphere. Cuba will probably be accepted back into the community of American States before the end of the century and perhaps by 1985. Cuba will probably still be identified as Marxist-Leninist, but ties with Moscow will wear thin as it realigns as a working member of the OAS.

Japan will remain a strong but much more independent ally. The United States will probably still be committed to the defense of Japan although that country may be well on the road to a policy of self-sufficiency in terms of island defense by 1985. Japan's broader interests and need for security of long lines of communication to pursue its economic objectives will continue to require a partnership with the United States.

Leadership in China is so dominant and centralized that historical trends are meaningless, or at least, subordinated to the ideologies and proscriptions of the political elite. The possibilities upon the death of Mao, from the evolution of an anti-West military regime to a moderate continuation of Maoist doctrines, are endless. One thing does appear relatively certain, however, and that is that a meaningful and stable Sino-U.S. alliance will not eventuate and that the United States will nourish

a containment policy for China in 1985. We foresee the continuation of a number of U.S. alliances in the Pacific and Asia including the ANZUS pact, a mutual defense treaty with the Philippines, and residual ties with Thailand. SEATO appears moribund and not likely to survive the century as an influential alliance. It is unlikely to be an effective instrument of U.S. foreign policy past 1985.

The prospects appear slim for an effective U.N. military peace-keeping force in 1985. The multinational, multibloc systems that will probably be generated in that period make the chances for an effective police role for the U.N. slight. The United States will continue to have the same commitment to support the U.N. with forces on call, but the degree of commitment will probably be as slight, interpretative and inconsequential as it is in 1974.

There will probably be an overall reevaluation of U.S. military commitments abroad in the next ten years. The results will be first, a general skepticism relative to the value of such commitments, secondly, a reevaluation and, finally, a selective recommitment to those nations which are most closely identified with U.S. national interests.

In the history of diplomacy the existence of a treaty or agreement has not been an infallible guide to the generation or implementation of foreign policy or for planning guidelines. The verbiage or degree of resolve which is found in formal statements of alliance are not the only criteria to be considered when circumstances dictate that a decision must be made as to whether a commitment is to be redeemed. We must assume that, when conditions require a decision concerning commitments implied in current or future alliances and agreements, the decision will be made in light of the perspective of national interest at that moment. The study of current or projected U.S. commitments will not in itself provide satisfactory answers to questions on defense guidelines. Instead, such commitments are highly fallible indices of future requirements. Confidence increases in using commitments as guideposts to future areas of operation when there is a convergence with contemporary national interests. Such convergence obviously exists today in Western Europe and Japan. It exists to a much

lesser degree in Liberia. Plans for U.S. forces for 1985 should, therefore, not lean on the thin reed of projected external commitments. To the extent that these commitments do impact, however, the following considerations apply:

- The United States will continue to have wide-flung world interests and will continue to rely on alliances to protect those interests.
- A requirement will still exist to provide military assistance to allies from Europe to Asia and perhaps into the subcontinent and Africa (Liberia, Ethiopia, Morocco).
- Military commitments will require a high order of strategic mobility and forward deployed forces.
- The total force concept will continue to provide a practical approach to force structuring both to economize and to structure forces for the most likely contingencies. However, allied capabilities are unlikely to increase in a relative sense (vis-a-vis the United States or potential allies) and the degree of reliance upon the United States for defense is not likely to be reduced.
- Great strides in economy and operation efficiency may still be made by 1985 in standardization of allied military equipment and procedures.

Interdependence of Nations

There is a perceptible increase in the concern for human rights both on an international and intranational scale. The trend is characterized by a lack of faith that our social institutions are adequate to meet the needs of today and not sufficiently flexible to change with the requirements of tomorrow. Even in some of the remotest parts of the world, public media, mobility and social awareness has increased the expectations of man for a more equitable share of subsistence. There is a need to preserve the dignity of the individual in the creation of institutions which are characterized by urbanization, gigantism, centralization, lack of privacy and insensitivity. As technology advances so must the generation of an advanced sense of scientific humanism. In the next decade there will be a rising demand for political and social justice and freedom by those nations and people who will feel the effects of drought, famine, pestilence, and the instability of a new emerging social order. We can only imagine that the U.S. will be a standard bearer in this search for better institutions to serve global needs. The security

implications are that the United States will, as previously stated, find it impossible to opt out of the world-wide responsibilities it has shouldered since 1945. The worldwide concern for human rights, global rising expectations and the harsh realities of a world in crisis will require a broader rather than a narrower perspective of world responsibility.

Ecological considerations will have a significant impact on the world over the decade. The common concern for preserving our seas and protecting the continents could tend to unify diverse interests in common concerns. These trends should be cohesive although perhaps not very perceptible in the short term. They may be masked by other, more significant events; nevertheless, they should have influence. Ecological concern promotes an approach or viewpoint which is difficult to define or direct but which provides an enlarged perspective of man's relations to his environment and a broader view of his political and national institutions. As propounded by Harold and Margaret Sprout, the common concern for maintaining a balance of the materials which sustain us should be a factor in making man aware of the universality of his responsibilities and the need to view the world as an entity.[1]

The impact of the continued growth of multinational corporations is an enigma. There is no doubt that they demonstrate a great potential to change the architecture of the nation-state system. However, there are few indications whether the change will be stabilizing or destabilizing, will redistribute or concentrate world assets, or will be pliable to national authority or uncontrollable. Multinational corporate activities which are primarily U.S. owned may, by their presence in other nations, insinuate U.S. interests into areas which have been historically of little U.S. national interest or concern. There are other international organizations which will also continue to change our view of the world order, some under the auspices of the U.N., some not. In sum, these organizations, such as the International Monetary Fund, the World Bank, the Food and

[1]Harold and Margaret Sprout, The Ecological Perspective on Human Affairs (Princeton, Princeton University Press, 1965).

Agricultural Organization, will continue to promote an increased interdependence of nations. Implicitly, they will also impose greater and greater economic and military responsibilities upon the haves out of concern for the have nots. This evolution and centralization of power will in the next decade cause all nations to reassess their views of national sovereignty. Over the long run there may be some diminution of national sovereignty to the gain of an international order but it will not likely be a perceptible or meaningful change in the next decade.

World Economic Order

> A continuing theme through these . . . past several years has been that the determining international developments of the last quarter century have been economic rather than military. The influencing factors in relations between nations have not been the existence of nuclear weapons, Soviet-American polarity, or Arab-Israeli intransigence. They have been the economic growth of Europe and Japan, the exploitation of Middle East oil and the discovery of vast raw materials in Australia, Africa, and South America. The tragedy of the period has been that politics, which is not an element in itself but a derivative of both military and economic strength, has been focused primarily on the military.[1]

If one had to guess the origin of the above quotation the assumption probably would be that it had been written by a doctrinaire economist or industrialist or at least from the relatively neutral viewpoint of a statesman or political scientist. In fact, it was authored by a professional naval officer in his assessment of the role of ocean transport in national strategy.[1] The case may be overstated here; nevertheless, it is obvious that economics is an important consideration in international behavior and that it does have substantial impact on military planning. It is also obvious that we are in a period of transition when the economic scene in the United States is undergoing change and when a "New Economic Order" has become a unifying theme for less developed countries. The 9 April 1973 special General Assembly session called by President Houari Boumedienne

[1]Rear Admiral John D. Hayes, U.S. Navy (Retired), "The Maritime World in 1973," United States Naval Institute Proceedings, p. 243 (May 1974).

of Algeria could be the initiation of an alliance of less developed countries to extract more favorable commodity prices and terms for those valuable resources they poseess. There is a natural forum and bureaucratic framework for such initiatives within the U.N., and Secretary General Waldheim has not discouraged such an alliance. His address at the special meeting, while carefully neutral, did appear to encourage what the New York Times has characterized as a "New Economic Order".[1]

> The main theme of this Assembly is to secure the optimum use of the world's natural resources with the basic objective of securing better conditions of social justice throughout the world.[2]

The lessons of the oil embargo, the OPEC negotiations and the quantum increase in oil prices have not been lost on countries which also recognize that:

- Australia and Guinea control over half of the world's reserves of bauxite.
- South Africa and Rhodesia have 96 percent of the world's chromium reserves.
- Spain has over half the world's mercury.
- Thailand, Malaysia and Indonesia control about 60 percent of the world's reserves of tin.[3]

It is important that we consider the impact of a no growth society upon the national security of the United States. Zero population growth (ZPG), if vigorously imposed today, would produce a gerontocracy within a couple of decades.[4] Zero economic growth (ZEG) (no definition has yet

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[1] New York Times, Editorial, p. 8 (8 April 1974).

[2] Kurt Waldheim, Speech of 9 April 1974 before the General Assembly, quoted in New York Times, p. C12 (10 April 1974).

[3] New York Times, Editorial, p. 8 (8 April 1974).

[4] For example, just a few years ago, for every one person on social security in the United States there were 22 persons contributing. Today, for every one person receiving these benefits only three are being taxed. By 1990 the ratio will be 1 to 1. Source: Hon. L. R. Preyer, M.C., Congressional Record, 17 June 1974, p. H5165.

been agreed upon) could have substantial psychological moral and attitudinal implications upon society. The excellent studies[1] of no growth recently published have generally assumed that ZPG and ZEG would not come about as the result of calculated policy - that they would not be planned and directed merely for the purpose of achieving a better social order. Near term ZEG will most likely eventuate not by choice but because of economic imperatives or economic failure. It would not be difficult to create a plausible scenario for zero or negative economic growth over a decade for the United States if the great bulk of national resources were diverted to a massive Manhattan-type project to find energy substitutes for petroleum products in alternatives such as solar or fusion fuels. The scenario would be based on the order of a $600 billion program over a six or seven year period in which all national resources were concentrated on this one enterprise as a matter of priority. The calculus of technological spin off and incidental growth from the enterprise would be difficult to interpret but the possibility of zero or negative economic growth under such circumstances is real.

Given the uncertainties of the world economic order in 1974, it is hazardous to attempt a definitive projection of conditions in 1985. Helmut Schmidt, while still Minister of Finance of the Federal Republic of Germany, made the following comment on the instability of the current order:

> Even after the mid-February Energy Conference in Washington, the impression, disturbing in many respects, remains that the world economy has entered a phase of extraordinary instability and that its future course is absolutely uncertain; it may bring stability, but also still greater instability. more integration, closer cooperation, an improved division of labor may increase the overall prosperity of nations. But the future course may just as well be characterized by disintegration, national isolation and the search for more self-sufficiency, thereby enhancing the contrasts already existing in the world.[2]

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[1]See particularly: "The No-Growth Society", (Daedalus, Fall 1973); Rudolf Klein, "Limiting Growth", op. cit.; Donella H. Meadows, et al., The Limits of Growth, (New York, Universe Books, 1972).

[2]Helmut Schmidt, "The Struggle for the World Product," Foreign Affairs, p. 437 (April 1974).

Notwithstanding the instability and inscrutability of the current world order of economics and the uncertainties of the U.S. domestic scene, the issues are too significant to dismiss. There are long range trends which will impact on defense planning guidelines which can be examined while addressing the following questions:

- What are the principal U.S. economic vulnerabilities which impact on national security?
- What are the principal U.S. economic strengths which impact on national security?
- How could U.S. security policy be formulated to maximize the strengths and minimize the vulnerabilities?

U.S. Vulnerabilities Evolving from Economic Factors

The four principal U.S. vulnerabilities which may be considered to evolve from economic factors are:

(1) Resource dependence
(2) LOC vulnerabilities
(3) World food problems (also considered a strength), and
(4) The spiraling costs of defense.

1. Resource Dependence

Two approaches to the resource dependence problem may be identified.[1] The first is an optimistic approach which implies that by capitalizing on technology for developing scarce resource substitutes or through new mining and extraction techniques (e.g., undersea mining) man will keep apace of his needs in the coming years. The second approach is pessimistic. The pessimist predicts a dwindling resource base without a compensating technology which will lead to ZEG and a lower standard of living.[2] The types of resource shortages which can be anticipated can be categorized as those which are

[1]Large portions of this paragraph have been paraphrased or taken directly from a companion-piece authored by Hazel Ellis of the Strategic Studies Center, SRI.

[2]These two policies are discussed in greater detail in an unpublished manuscript entitled "Ecology and National Security," by John J. Ford of the Strategic Studies Center, SRI.

generated because the raw materials:

- Are nonrenewable and in short supply
- Are required and are not produced by the United States
- Are required and not produced by the United States but are controlled by a very few countries
- Are in more than one of the above categories.

Referring to the first concern, testimony before the Joint Committee on Defense Production revealed: (1) that there is an ever-increasing competition for raw materials in world markets, (2) that easily accessible high-grade ore deposits either have been or are being exhausted, (3) that the level of activity and results of the present exploration program for metals and ores have been disappointing, (4) that the development of reserves is declining for a wide range of materials, (5) and that technology has not been developed to lower costs and increase available supply from marginal and submarginal resources. The testimony also indicated that the trend for a growing number of primary minerals is toward higher costs,[1] and that domestic production is leveling off with more frequent recourse to substitutes.

With reference to the second and third concerns, the National Commission of Materials Policy (as a result of a study of U.S. demand of natural resources compared to supply, up to the year 2000) has concluded that "in the case of a majority of our basic materials, the gap between our requirements and the remaining easily accessible world supplies is widening."[2]

Table 1 lists minerals, the percentage of these minerals that was imported into the United States in 1972, and the major foreign sources of these minerals. Table 2 shows the extent to which the United States is

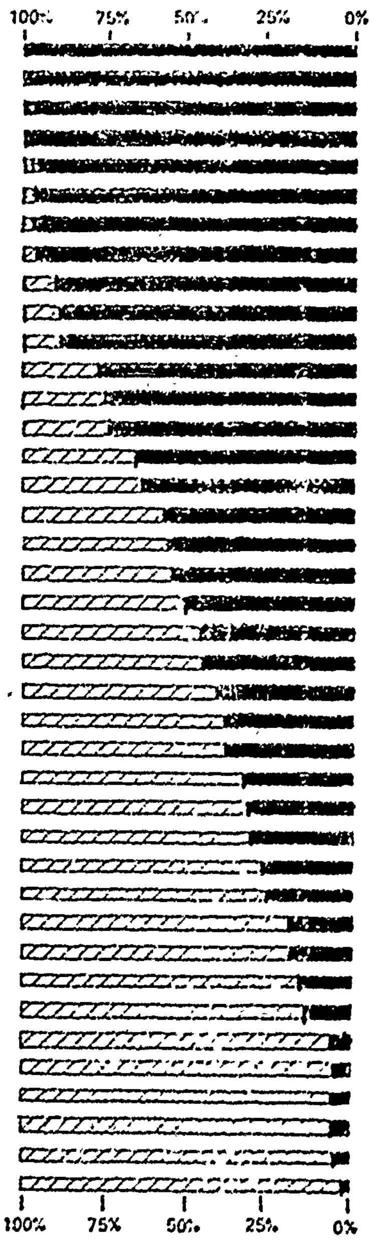
[1]A good example of what may become a world wide trend is that the world's leading exporter of bauxite, Jamaica, has outlined plans to nearly triple the taxes and royalties on that resource which is the base for aluminum. Justification for the increase was cited as the nation's yearly oil bill which for 1973-74 tripled from $50 million to $150 million. Source: New York Times, pp. 1-61 (17 May 1974).

[2]J. McHale, The Ecological Context, p. 140 (George Braziller, New York 1970).

Table 1

IMPORTS SUPPLIED SIGNIFICANT PERCENTAGES OF TOTAL U.S. DEMAND IN 1972

PERCENTAGE IMPORTED



MINERAL	MAJOR FOREIGN SOURCES
PLATINUM GROUP METALS	UK, USSR, SOUTH AFRICA, CANADA, JAPAN, NORWAY
MICA (sheet)	INDIA, BRAZIL, MALAGASY
CHROMIUM	USSR, SOUTH AFRICA, TURKEY
STRONTIUM	MEXICO, SPAIN
COBALT	ZAIRE, BELGIUM, LUXEMBOURG, FINLAND, CANADA, NORWAY
TANTALUM	NIGERIA, CANADA, ZAIRE
ALUMINUM (ores & metal)	JAMAICA, SURINAM, CANADA AUSTRALIA
MANGANESE	BRAZIL, GABON, SOUTH AFRICA, ZAIRE
FLUORINE	MEXICO, SPAIN, ITALY, SOUTH AFRICA
TITANIUM (rutile)	AUSTRALIA
ASBESTOS	CANADA, SOUTH AFRICA
TIN	MALAYSIA, THAILAND, BOLIVIA
BISMUTH	MEXICO, JAPAN, PERU, UK, KOREA
NICKEL	CANADA, NORWAY
COLUMBIUM	BRAZIL, NIGERIA, MALAGASY, THAILAND
ANTIMONY	SOUTH AFRICA, MEXICO, UK, BOLIVIA
GOLD	CANADA, SWITZERLAND, USSR
POTASSIUM	CANADA
MERCURY	CANADA, MEXICO
ZINC	CANADA, MEXICO, PERU
SILVER	CANADA, PERU, MEXICO, HONDURAS, AUSTRALIA
BARIUM	PERU, IRELAND, MEXICO, GREECE
GYPSUM	CANADA, MEXICO, JAMAICA
SELENIUM	CANADA, JAPAN, MEXICO, UK
TELLURIUM	PERU, CANADA
VANADIUM	SOUTH AFRICA, CHILE, USSR
PETROLEUM (inc. Nat. Gas liq.)	CENTRAL & SOUTH AMERICA, CANADA, MIDDLE EAST
IRON	CANADA, VENEZUELA, JAPAN, COMMON MARKET (EEC)
LEAD	CANADA, AUSTRALIA, PERU, MEXICO
CADMIUM	MEXICO, AUSTRALIA, BELGIUM, LUXEMBOURG, CANADA, PERU
COPPER	CANADA, PERU, CHILE
TITANIUM (ilmenite)	CANADA, AUSTRALIA
RARE EARTHS	AUSTRALIA, MALAYSIA, INDIA
PUMICE	GREECE, ITALY
SALT	CANADA, MEXICO, BAHAMAS
CEMENT	CANADA BAHAMAS NORWAY
MAGNESIUM (nonmetallic)	GREECE, IRELAND
NATURAL GAS	CANADA
RHENIUM	WEST GERMANY, FRANCE
STONE	CANADA, MEXICO, ITALY, PORTUGAL

Source: U.S. Department of the Interior, "Mining and Minerals Policy," 1973.

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Table 2

U.S. DEPENDENCE ON EXTERNAL SUPPLIES OF PRINCIPAL INDUSTRIAL RAW MATERIALS: 1970 WITH PROJECTIONS FOR 1985 and 2000

Raw Material	Percent Imported		
	1970	1985	2000
Aluminum	85	96	98
Chromium	100	100	100
*Copper	0	34	56
Iron	30	55	67
Lead	31	62	67
*Manganese	95	100	100
*Nickel	90	88	89
Phosphate	0	0	2
Potassium	42	47	61
Sulfur	0	28	52
Tin	n.a.	100	100
Tungsten	50	87	97
Zinc	59	72	84

*May be available in abundance with deep seabed mining of manganese modules which bear copper, nickel, manganese and cobalt. (Almost all of U.S. cobalt is imported--see Table 1).

Source of basic table: L. R. BROWN, "The Interdependence of Nations," Foreign Policy Association, New York, October 1972, which credits data as being derived from publications of the U.S. Department of the Interior

expected to be dependent on foreign sources for 13 basic industrial raw materials in 1985 and the year 2000.

The United States and other industrialized countries are, at the present time, still highly dependent on iron and the main alloying metals of manganese, chromium, nickel, molybdenum, tungsten, cobalt, and vanadium. As Table 2 indicates, by 1985, assuming no technological breakthroughs in extraction processes or new mineral sources, the United States will be dependent on foreign sources for most of these materials. No material in use at the present time rivals the range of qualities available in steels. However, with aluminum, magnesium, composites, and plastics coming into mass production,[1] we can anticipate some relief from such dedicated reliance on steel. (For example, at very high temperatures, in aerospace and supersonic aircraft work, where atmospheric reentry heats go beyond the melting point of most steels, they have been superseded by ceramic refractory coatings and refractory alloys of other minerals.)

The relative importance of tin as a "strategic" metal lies in alloying. Important deposits of tin ores occur in only a few parts of the world. Titanium has now reached volume production as a major structural metal with very high strength-to-weight ratios that outperform columbium and magnesium alloys for many purposes. For example, in 1965, the latest Mach 3 aircraft was one of the first all-titanium planes. Imports of rutile, the basic raw material for titanium metal, have increased sharply. The majority of our supply for this material comes from Australia.

Development of atomic weapons and other nuclear energy uses have made uranium, radium, thorium, and plutonium extremely important metals. However, estimates of uranium and thorium reserves in the United States alone are hundreds of thousands of times greater than the initial supply of fossil fuels.

Deep seabed mining enterprises will be discussed at several points in this module - the potential should be placed in perspective as an illustration of what can be expected from technology to relieve U.S.

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[1] J. McHale, The Ecological Context, p. 140 (George Braziller, New York, 1970).

dependence on imported resources. First, the technology for such mining is fairly well advanced. U.S. development of ocean mining techniques was started in 1962 by the Newport News Shipbuilding and Dry Dock Company. A pilot processing plant was developed in 1971. The research and basic test and development stage appears to have been completed. The remaining stages of the effort will be expensive and time consuming. A three-year advanced development and evaluation program has been started by a U.S. firm in partnership with three large Japanese companies. The partnership anticipates eventual expenditures of about $200 million. Nodules will be mined from depths up to 2 1/2 miles in both the Pacific and Atlantic. The composition of the nodules includes about one percent copper, one percent nickel, and over 25 percent manganese.[1] A second U.S. firm has joined in partnership with two British, one Canadian and one Japanese firm to mine deep sea nodules. The organization of other sea-mining consortiums should be anticipated. Deep sea exploration and mining is fast outstripping the international legal initiatives to promote the conservation and orderly development of the deep seabed. The United Nations Law of the Sea Conference, scheduled for 20 June to 29 August 1974, in Caracas, Venezuela, is to include this subject on its agenda. In summary:

- Deep seabed mining appears to have great potential for providing new sources of minerals for the United States.
- Deep seabed mining research, test and development thus far has been a relatively expensive undertaking.
- Deep seabed mining initiatives will continue to be expensive and time consuming which indicates it is not a cheap, quick solution to U.S. problems.
- Deep seabed mining efforts have been undertaken principally by international consortiums which poses interesting long-range political, economic and security implications.

We have focused on minerals and deep sea mining not because these are the only considerations but because they are enlightening and characteristic of the overall problem. The obvious impact of petroleum dependence has been thoroughly analyzed and discussed in a number of other sources. However, the significant point which needs to be made is that

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[1] Congressional Record, pp. S7552, S7553 (9 May 1973).

U.S. energy, at least over the near (ten year) term, is going to be more expensive than ever before. U.S. dollar outflow for imported fuels could rise from 2 billion in 1970 to as high as 30 billion in 1985.[1] Such an outflow would have a disastrous effect on the balance of U.S. trade and in turn produce serious world crisis and instability. The total "oil deficit" for 1974 is estimated to be $65 billion with Italy's share being $8 billion and the U.K. $10 billion. By 1980 it is authoritatively predicted that the oil-importing countries will be forced to borrow hundreds of billions of dollars from the oil producing countries to pay for the oil they require.[2] There do not appear to be any "quick-fixes" for alleviating U.S. and allied dependence on importation of resources. On balance, the view of the pessimist cited earlier in this section seems closer to the mark than the view which anticipates quick relief from dependence through technology. While in the long run, technology shows promise for uncovering alternative sources and materials, over the short run, diplomacy, economic bartering and perhaps even military force may be the instruments required to insure Western and Japanese access to the raw materials required to maintain the current, much less an expanded, industrial base.

While the oil dollars are flowing out of the West they are flowing into the coffers of a few nations, some of which have an insufficient need or base upon which to spend this currency. In 1974, the twelve OPEC countries could garner a trade surplus of $65 billion, from a base of only $7 billion in 1973.[3] While Italy verges on bankruptcy Saudi Arabia, Kuwait, the United Arab Emirates and Libya are hard pressed to put their surplus largesse to work. So much of the world's monetary inventory in the hands of a few countries has all the makings of a massive economic crisis that could throw the world into financial chaos. The best hedge against such chaos

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[1] James E. Lee, President, Gulf Oil Corporation in Yuan-li Wu, Raw Material Supply in a Multipolar World, p. x (New York, Crane, Russak & Co., 1973)

[2] New York Times, p. 40 (15 May 1974).

[3] Time, p. 83 (17 June 1974).

is an OPEC which recognizes its share in and responsibility for a stable world economic order. Under the best of circumstances, the next ten years will produce a fiscal instability which will have a serious impact on the United States but which could spell disaster for U.S. allies and poorer nations.

The 10% devaluation of the U.S. dollar in February of 1973 was acknowledgment of the shaky status of this currency in the world market. The energy crisis and failure of the U.S. economy to respond to the emergency measures which have been taken portends more instability and perhaps more devaluation. In itself these concerns are serious enough, however, as they erode confidence in the U.S. stability and economic health, confidence is eroded worldwide on the ability of the United States to keep its commitments and upon the "free enterprise" systems superiority over a Marxist-Leninist world order. While these problems are critical they should be kept in perspective. While the United States may have serious problems, in a relative sense it will still be the economic and industrial leader of the world.

Eastern Europe is as dependent as Western Europe upon imported petroleum products. How the Soviet Union dispenses its large but not unlimited oil reserves during periods of short supply and high prices may have great impact on the cohesiveness of the Warsaw Pact. In 1973, the Soviet Union increased its exports of oil and petroleum products more than ten percent but realized a forty-four percent increase in profit. The additional profits came exclusively from non-communist customers which indicates that the Soviets may hold down prices for their favored allies while capitalizing on increased market prices for others such as Denmark, West Germany, Belgium, and Italy. While the Middle East was boycotting the Netherlands in the fall of 1973 the Soviet Union increased their exports to the Dutch by a third at about three and a half times the 1972 price.[1]

[1]Christopher S. Wren, "Russia Has Windfall Profit on Increased Oil Prices," Congressional Record, p. E4084 (21 June 1974).

2. <u>Lines of Communication</u>

If the United States continues to rely upon essential resources imported from other nations (as it must), it will continue to rely upon its lines of trade communications. Fortunately, Canada is one of the principal sources of many of the materials upon which the United States is dependent. Of the forty critical U.S. imports cited in Table 1, Canada exports twenty-three. Of the same forty imports, Mexico exports fourteen. Only six of the forty imports listed in Table 1 are not exported from the American continent and four of those six are insignificant in terms of U.S. dependence. The critical imports are therefore in chromium (USSR, South Africa and Turkey are major foreign sources) and titanium (Australia is the principal foreign source). These generalizations leave much unsaid and tend to understate the problem of U.S. lines of communication to sources of supply. Significantly they do not include oil. While only one percent of the U.S. total crude oil supply was carried over Atlantic LOCs in 1968, by 1985 that figure could be increased substantially. The United States' most sensitive vulnerability lies in the critical dependence of its Western and Japanese allies upon sea lines of communication. Yuan-li Wu has cited some interesting statistics on the imports of our principal allies over critical LOCs which are cited in Tables 3, 4, and 5. The sea routes (graphically portrayed on Map No. 1) have been selected and categorized by Dr. Wu and appear to provide a useful contribution to this taxonomy. The five metals displayed for examination were selected on the basis of weight, value and importance in industrial production. Manganese could have been included as it met all the criteria. However, data was not available for this metal and therefore it was omitted.[1] All import percentages over 25 are circled in the tables for emphasis. The 25 percent level was selected as critical in indicating that a nation was substantially dependent upon a single area source or a single route for a significant commodity.

[1]Yuan-li Wu, op. cit., p. 7.

Table 3

Percent of Total Supply of Selected Metals to Selected NATO Countries Carried Over Different Sea Routes, 1968

Route Description	Iron Ore	Copper	Lead	Zinc	Bauxite	Country
1. The Mediterranean	0.1	-	-	-	16.5	West Germany
	0.4	-	-	-	22.2	United Kingdom
	0.2	-	24.2	16.1	2.0	France
2. The Indian Ocean and the Eastern Atlantic (for exporting countries in South Asia, the Middle East, and East Africa)	0.4	-	-	-	-	West Germany
	0.1	40.9	-	-	5.4	United Kingdom
	0.2	32.7	-	0.2	-	France
3. The Eastern Atlantic, including the North Sea (for suppliers in West Africa and Scandinavia)						
Africa	18.7	33.0	4.6	0.8	18.7	West Germany
	26.6	-	3.2	-	-	United Kingdom
	4.0	-	-	-	-	France
Sweden and Norway	31.4	-	-	-	-	West Germany
	17.7	-	-	-	-	United Kingdom
	0.5	-	-	-	-	France
4. Across the Indian Ocean and the Eastern Atlantic (for suppliers located east of the Malacca Strait, such as Australia)						
Australia	2.8	-	1.5	0.2	20.2	West Germany
	0.8	-	30.9	54.2	-	United Kingdom
	0.4	-	11.2	-	7.0	France
Asia	1.2	-	0.9	-	-	West Germany
	-	-	-	-	-	United Kingdom
	-	-	-	-	-	France
5. Across the Atlantic (from countries in North and Latin America)						
North America	4.6	11.0	26.4	24.8	-	West Germany
	10.7	26.9	12.2	21.7	-	United Kingdom
	-	14.1	1.7	18.0	-	France
Latin America	16.7	32.5	7.8	4.0	4.8	West Germany
	7.2	22.9	9.7	1.3	6.3	United Kingdom
						France

Legend: All statistics over 25 percent are circled ○ for emphasis.

Source: Derived from Yuan-li Wu, Raw Material Supply in a Multipolar World, op cit., pp. 24-27 which cites United Nations, "Monthly Bulletin of Statistics," (January 1974) Charles, L. Kimbell, "Minerals in the World Economy," in Bureau of Mines, U.S. Department of Interior, "Minerals Yearbook 1969," Vol. 4.

Table 4

Percent of Total Supply of Crude Oil to Selected NATO Countries
Carried over Different Sea Routes, 1970

Route Description	West Germany	United Kingdom	France
1. The Mediterranean	48.0	26.2	43.4
2. The Indian Ocean and the Eastern Atlantic (for exporting countries in South Asia, the Middle East, and East Africa)	31.6	60.8	44.1
3. The Eastern Atlantic, including the North Sea (for suppliers in West Africa and Scandinavia)	6.8	7.5	6.4
4. Across the Indian Ocean and the Eastern Atlantic (for suppliers located east of the Malacca Strait, such as Australia)	-	-	-
5. Across the Atlantic (from countries in North and Latin America)	3.2	4.9	2.2

Legend: All statistics over 25 percent are circled ◯ for emphasis.

Source: Derived from Yuan-li Wu, op cit., p. 27 who cites World Energy Supplies, 1961-1970, UN Statistical Papers, Series J, No. 15 (New York: United Nations, 1972).

Table 5

Percent of Total Supply of Crude Oil and Selected Metals to Japan Carried Over Different Sea Routes, 1968

Route Description	Crude Oil*	Iron Ore	Copper	Lead	Zinc	Bauxite
6. The Asian waters east of the Malacca Strait						
Australia	0.2	18.9	-	13.4	8.2	37.4
Indonesia	12.9	-	-	6.6**	4.2**	30.9
Other	-	7.0	-	-	-	28.0
7. Across the Indian Ocean and through the Malacca Strait	85.2	17.4	41.6	0.4	-	0.4
8. From the Eastern Atlantic (for West African suppliers) across the Inidan Ocean and through the Malacca Strait	1.7	8.8	-	-	-	0.4
9. Across the Pacific						
North America	neg.	7.5	6.1	16.6	4.6	-
Latin America	0.3	24.9	13.7	17.5	29.0	2.3

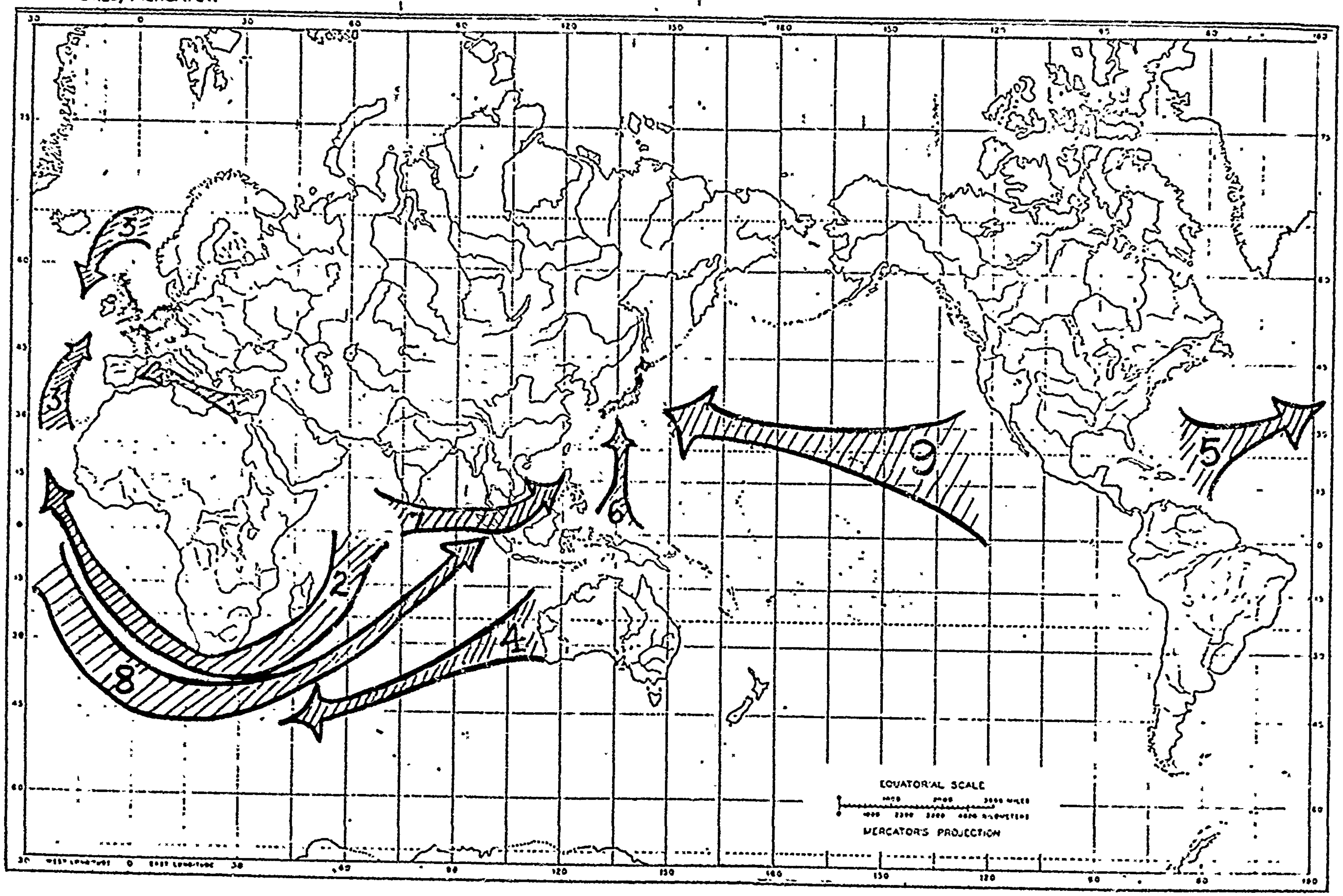
* The data are for 1970.

** All Asia

Legend: All statistics over 25 percent are circled for emphasis.

Source: Derived from World Energy Supplies, 1961-1970, UN Statistical Papers, Series J, No. 15 (New York: United Nations, 1972).

WORLD, MERCATOR



MAP NO. 1

CRITICAL SEA LINES OF COMMUNICATIONS TO U.S. ALLIES

A study of the three tables provides some interesting observations about the vulnerabilities of our principal allies' sources and routes of imports on crude oil and the five selected commodities:

- The tables demonstrate that there may be some meaningful flexibility in the selection of sources and routes. While West Germany secures 33 percent of its imported copper from West Africa, the UK and French imports from that area are statistically irrelevent. The UK and France are heavily dependent upon the areas east of Suez. Should one of these alternative sources be closed to our allies it appears that there could be a possibility that the other would remain open. There is no need to develop extensive scenarios to demonstrate that there are alternatives to the patterns displayed here.
- Notwithstanding the degree of flexibility that exists in going to alternate sources and routes, the Atlantic appears to be the most heavily travelled and therefore the most vulnerable for imports of NATO allies for both oil and the five commodities. Geography, of course, dictates that the Eastern Atlantic, the terminus of the bulk of the routes, is most critical.
- The Mediterranean as well as the Atlantic includes the critical routes for NATO oil imports.
- The single, most vulnerable access route for our allies is through the Malacca straits, a route over which 85.2 percent of the Japanese crude oil is delivered and 41.6 percent of her copper. As indicated in the geography section of this module, there are alternative routes open further to the east but they add substantial distance to the LOCs.
- Without emphasizing the obvious, our allies are committed to extremely vulnerable, long lines of sea communications for crude oil and critical resource commodities.
- While the United States has LOC vulnerabilities, those of the U.S. allies appear to be much more serious. To the degree that the United States remains committed to the defense of Japan and NATO, the United States must take those steps necessary to insure continued free use of these vital LOCs.

In ten years this resource dependence and LOC problem could change substantially. The United States and its allies, through technology, could either find new extraction methods or resource substitutes which

would free them of such reliance upon the long lines of communication currently used. Alternative transportation systems, air or subsurface might be developed which would reduce vulnerability in terms of either time of exposure (rapid air transport) or limit or exposure (subsurface ocean cover). Highly efficient defensive naval and ground air systems could be developed to provide guarantees of safe passage. It does not seem prudent to anticipate that any one of these alternative possibilities will eventuate as described nor, on the other hand, does it seem prudent to ignore them. To some degree the United States and its allies will undoubtedly still be dependent on these same lines of communication for the same commodities in 1985. To some extent nuclear energy technology may relieve Japanese dependence upon oil and therefore dependence on the Malacca straits.[1] To some extent lighter than air craft may relieve dependence upon sea lines of communication and perhaps less vulnerable underwater cargo ships and tankers may prove practical. To some extent hydrofoil and surface effect craft and ASW techniques may provide better security for cargo vessels to

[1]To place this possibility in perspective, the following is quoted from: Amory B. Lovins, "World Energy Strategies," Bulletin of the Atomic Scientists, pp. 18, 19 (May 1974):

> The aggregate amounts of energy now being converted are so prodigious that voluntary rapid change in supply patterns is physically impossible. For example, suppose that our present world conversion rate of 8 trillion watts - 97 percent of it from fossil fuels - continues to grow (as most authorities predict and urge) by about 5 percent per year for the rest of this century, yielding a 3.7-fold increase to about 3 x 10^{13} watts. If we could somehow build one huge (1 gigawatt=1,000 megawatt (electrical)= 1 billion watts (electrical) nuclear power station per day for the rest of this century, starting today, then when we had finished, more than half of our primary energy would still come from fossil fuels, which would be consumed about twice as fast as now. Few knowledgeable people would say that such a rapid nuclear infusion is possible, even were it advisable. On the other hand, such rapid sustained growth in energy conversion as we have just assumed will not actually occur, owing both to supply constraints and to the moderation in demand which these constraints will encourage and compel.

in transit passage. On balance, however, it is believed that LOC vulnerabilities for 1985 will be substantially the same as 1974. We should anticipate a few innovations and developments which, while not redeeming the situation, may have kept it from becoming worse.

In May 1974, just prior to his retirement as Chief of Naval Operations, Admiral Zumwalt stated that he was convinced that the United States had lost to the Soviet Union its ability to control the world's sea lanes. The Soviet Union's "capability to deny us the sea lines, which is their job, is greater than our capability to keep the sea lines open, which is our job," he is reported to have said.[1] The solution? "If the Congress funds adequately the five-year (shipbuilding) plan, we can reverse that situation."[2] The statement is undoubtedly correct and, based on this very brief discussion of LOCs, it can be judged that it is a very significant appraisal. The appraisal generates more question than conclusions, however. Some of them follow:

- Does the United States have the capability of denying the Soviet Union its sea lines of communication?
- If the United States has the capability to deny the Soviets their sea LOCs, what is the net effect:
  - A Mexican standoff with neither side accruing an advantage?
  - A net gain for the Soviet Union because it and its allies are less dependent upon their sea LOCs?
  - A net advantage to the United States because the combined naval forces of the NATO alliance exceed that of the Warsaw Pact?
- In view of the extensive sea LOCs upon which the United States and its allies are dependent, geography, and the state of offensive warfare against shipping, is it possible to realistically, or within any reasonable limit of economy, guarantee the security of any combination or all of these sea LOCs?

[1] New York Times, p. 24 (14 May 1974).

[2] Wall Street Journal (13 May 1974).

- Has the 1973 oil crisis demonstrated that it is much more effective and feasible to interdict lines of communication at the source rather than across the seas and airways?

What we are attempting to demonstrate here is that the existence of a threat to U.S. or allied security must not always lead to building forces to defeat the threat. Ballistic missile defense (BMD) is a parallel case. It has never been suggested by even the most defense oriented observers that the United States should construct a system which would guarantee the invulnerability of all the fifty states and its territories from hostile missile attack. The task is probably technologically infeasible and even if feasible it would be exorbitantly expensive. Most defense oriented observers sought a more practical solution -- defend U.S, missile sites, the national command authorities and certain principal cities and rely upon deterrence from the strategic offensive capability of the United States. Defense of sea LOCs could pose a similar dilemma. It may not be possible to guarantee security of the principal sea LOCs either technologically or economically. The U.S. offensive capability for retaliating against Soviet or Warsaw Pact LOCs may be the appropriate posture - a conventional naval deterrent force. There are many other potential responses to a Soviet attempt to sever Western Alliance and Japanese LOCs. The threat does not necessarily require structuring a naval force which will guarantee the security of these critical routes in peace and war.

3. World Food Problems

As indicated earlier, the economics of feeding the world constitute both a vulnerability and an advantage to the United States. This section will treat the economic implications of the commodity on both counts, i.e., as a vulnerability and as an asset.

The United States is vulnerable in that there will be greater demands upon U.S. domestic food stocks. The United States is at an advantage in that it has the most essential commodity of all for barter - the basic sustenance of man, which must take precedence in importance even over industrial energy commodities. In this respect, there is a conflict of purpose and interests taking shape. On the one hand, there are the economic pragmatists such as the prominent consultant on international trade, Frank Gard Jameson, who argues that food is an economic asset which must be used

prudently to offset the dollar drain the United States is suffering to purchase energy.[1] On the other hand, there are those who are guided by the moral implications of the U.S. larder. Senator Humphrey, who has petitioned for a U.S. policy to contribute generously to a world food action program to alleviate starvation and mass deprivation, is of this bent.[2] A mid-course seems to be expressed by administration spokesmen such as the Secretary of Agriculture, Earl L. Butz, who cites problems associated with increasing aid in terms of food but argue that current stocks and anticipated agricultural production in 1974-75 provide a sufficient cushion of surplus to permit a generous outlay of aid without raising U.S. food prices or dissipating the U.S. treasure.[3] The delegates to the U.S. conference to discuss the food and energy crisis (cited earlier) have called for "bold new programs" to deal with these scarcities. The participants estimated that, as a result of these two crises, the poorer nations of the world would have to pay $15 billion more for essential imports in 1974 than in 1973. The $15 billion figure is twice what is currently being given in assistance from more developed nations.[4] The Secretary General of the oil producing countries Organization of Petroleum Exporting Countries (OPEC) has indicated that those nations (the oil producers) are prepared to share their profits with lesser developed countries at the rate of 1 percent of their GNP per annum. The delegates made a special appeal to the United States and Japan to meet the bulk of the remainder of the $15 million estimated deficit of the poorer nations. Implied in the conference recommendations is not only a monetary support program but also the stockpiling of food resources for humanitarian purposes. Both programs would be administered under the auspices of the UN.[5]

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[1]Frank Gard Jameson, "Don't Give our National Treasure Away," (Guest Editorial), Armed Forces Journal International, p. 5 (April 1974).

[2]New York Times, p. 34 (14 May 1974).

[3]Ibid., pp. 1, 10 (13 May 1974).

[4]Ibid., p. 11

[5]Ibid., (13 May 1974).

Table 6 provides revealing statistics on the trends for consumption of cereals among nations. The substantial increase in consumption is due principally to an increase in affluence and social expectations to include an appetite for red meat. The following citation of food commodity facts, as they are now known, provides further perspective:

- India's 1974 import requirements of food grain are estimated to be 5 million tons or nearly 10 percent of a U.S. 1974 bumper crop which is anticipated. (India's plight has been exacerbated by the shortage of fertilizer attributable to the energy/oil crisis and an otherwise poor crop.)
- In 1974, for the first time in more than twenty years, the United States does not have large reserve stocks of grain in storage.[2]
- In 1973, U.S. agricultural exports of $18 billion were almost double those of 1972 at $9.4 billion. They are up from an average of $6.7 billion in the previous five years.[3]
- Two-thirds of the world's population consume only one-fourth of the world's protein.[4] (See Table 7.)
- Less developed countries food production has increased at generally the same rate as that of developed countries. However, less developed countries populations have increased at a dramatically higher rate than developed countries. Therefore, less developed countries, while maximizing crop yields, have, because of population increases, produced no more food per capita.[5] (World population increases are averaging 2 percent per year.)
- By 1985, the lower income countries dependence upon food imports is expected to double over that of 1970.[6] Given a straight line projection, those requirements could double again by 1995.

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[1]New York Times, p. 10 (13 May 1974).

[2]Ibid.

[3]Lyle P. Schertz, "World Food: Prices and the Poor," Foreign Affairs, p. 511 (April 1974).

[4]Ibid., p. 512.

[5]Ibid., p. 516.

[6]Ibid., p. 518.

Table 6

Per Capita Cereal Consumption
(in pounds)

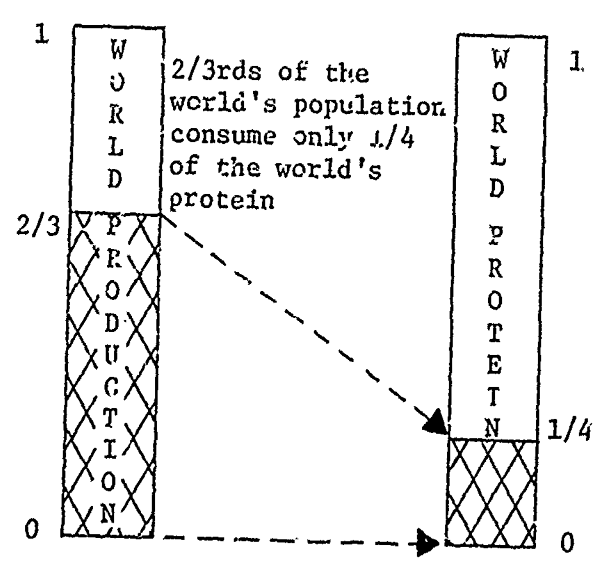
	1964-1966 Average	1972-74 Average	Percent Increase
United States	1600	1850	16
USSR	1105	1435	30
European Community	900[1]	1000[1]	11
Japan	530[1]	620[1]	17
China	420	430	2
Developing Countries (ex-China)	370[2]	395	7[2]

1 Figures for the cereal consumption of the European Community, and to a lesser extent of Japan, are reduced somewhat by the extensive use of non-cereal grains for livestock feeding. Japan's figure is also reduced by the fact of extensive direct imports of meat, thus cutting the livestock consumption of cereals within Japan.

2 The 1964-66 figure was depressed in the averages by India's two bad crop years in that period. The percent increase to 1972-74 thus exaggerates an increase that was in fact minimal.

Source: Lyle P. Schertz, "World Food: Prices and the Poor," Foreign Affairs, p. 514 (April 1974) citing Economic Research Service, U.S. Department of Agriculture.

Table 7



- Fertilizers essential to high agricultural production are largely petroleum based and have therefore become drastically more expensive and in short supply. If world food yields are to keep pace with the population growth, production of nitrate fertilizer must increase about 100 times in this century.[1]

- Since 1954, over $22 billion worth of U.S. farm commodities have been consigned to other countries.[2]

- Much of mankind spends about 60 percent of their income on food.[3]

- Soybeans are the leading export product of the United States, surpassing wheat, corn, electronic computers and jet aircraft.[4]

Food is a vulnerability for the United States in that the have-not nations demonstrate a desperate need for the U.S. agricultural treasure and yet have insufficient resources to pay for their requirements. Such desperation, if not satisfied at least in part by the United States, could generate antipathies and hostilities which could seriously threaten U.S. interests abroad including access to some critical commodity import markets. If such should eventuate, the use of U.S. military forces structured for operating in primitive environments might be required. The emphasis on military planning would be on contingency operations at the lower levels of conflict with readily deployable CONUS-based, mobile, general purpose forces.

Food is also an asset for the United States. It is an asset that may serve as the ridgepole for redressing U.S. balance of payments and trade imbalances. Revenue from U.S. exports of food could compensate in large measure for increased revenue outflow stemming from the oil crisis.

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[1]Lovins, op. cit., p. 17.

[2]Schertz, op. cit., p. 532.

[3]Lester R. Brown, "Global Food Insecurity," Congressional Record, p. S7100 (6 May 1974).

[4]Ibid., p. S7101.

4. <u>The Spiraling Costs of Defense</u>

There is probably no question more thoroughly discussed during cyclic budget analysis than the one addressing "how much defense is enough?" The FY1974 budget request for defense represents 29 percent of the total budget.[1] One critic estimates that the United States spends 95 percent of all military funds expended in this hemisphere and 60 percent of all military funds expended in the world.[2] Each year there is a proliferation of thorough studies advocating and justifying widely divergent positions on defense spending. While the studies do present conflicting conclusions, one area of agreement is consistently reflected: unit costs of equipment and manpower are increasing. The following quotations are relevant:

- Probably no defense subject has received more attention in national forums and the media during the past several years than the growth in cost of new weapons or weapons systems. The formidable costs are caused principally by:

  - Increases resulting from the greater capability demanded of new systems which, in turn, require greater complexity;
  - Inflation; and
  - Increases resulting from the way a weapon program is managed during development, design, and production.

- The military services constantly demand that the performance and capabilities of new systems exceed those to be replaced, to meet threats and to exploit new technology. Consequently today's weapons have become increasingly complex and therefore, as is well known, more costly than the systems of 10 to 20 years ago.[3]

- The cost growth phenomenon of recent years is not new. It is documented well back into the 1950s.

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[1] <u>The United States Budget in Brief, Fiscal Year 1975</u>, Executive Office of the President, Office of Management and Budget.

[2] Honorable Robert L. Leggett, Member of Congress, Additional view to HR Report No. 93-1035, <u>Committee on Armed Services Report to Accompany HR 14592</u>, p. 100 (10 May 1974).

[3] Comptroller General of the United States, <u>Cost Growth in Major Weapon Systems</u>, Report to the Committee on Armed Services, House of Representatives, p. 1 (26 March 1973).

- The cost of each successor system is between two and six times greater than its predecessor. This might be described as "performance cost growth" -- the tendency to constantly seek higher performance systems. This is one of the most serious aspects of cost growth.[1]
- Inflation accounted for . . . 30 percent of the cost growth.[2]
- The increase in the cost of that payroll over the past 10 years has been dramatic. The average pay of a soldier is $8,728. In 1964 it was $4,378. The increase is mainly due to comparability pay legislation.[3]
- What does it cost to support a single soldier today? One authoritative source puts the figure at over $18,000 a year, including pay and allowances, medical and administrative costs, and retirement pension costs. In 1965, the figure was barely over $8,000 per man.[4]

Administration officials have consistently emphasized that the FY1975 budget in constant dollars was smaller than the FY64 budget, that the FY75 budget still does not exceed 6 percent of the GNP and that defense consumes less of the total FY75 budget than previously.[5] Nevertheless, unit costs of defense in terms of systems and manpower have increased substantially. There are no indications that this trend will be reversed. It is possible that such trends may be slowed through emphasis on management systems such as value engineering, life cycle costing, better contracting practices, better resource management, better R&D goals, longer first-term enlistments,

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[1] Comptroller General of the United States, Cost Growth in Major Weapon Systems, Report to the Committee on Armed Services, House of Representatives, p. 17 (26 March 1973).

[2] Ibid., p. 3

[3] Duncan Spencer, "The Price of Today's Army," Washington Star-News, p. 6 (3 May 1974).

[4] Ibid.

[5] James R. Schlesinger, Statement Before the Senate Armed Services Committee on the FY1975 Defense Budget and FY1974 Supplemental Budget Requires (5 February 1974).

better second-term reenlistment performance, etc., but it is doubtful that the trends will be stopped or reversed. The higher personnel costs (which now represent 56 percent of the defense budget up from 42 percent in 1968)[1] are not directly and entirely attributable to inflation or the all-volunteer force. The increased personnel costs are mainly the result of an ethical, social decision made by the United States to provide equitable pay to its armed forces. The concept of service in the armed forces has been changed. No longer is the individual soldier, draftee or volunteer, being asked to contribute a type of tax not imposed on other segments of the population. Having made this very significant decision, it would appear that with or without a draft it would be impossible or at least difficult to return to a system which compensated the individual soldier at a level far below his civil counterpart -- at least not without some type of universal national service requirement which provided equity among citizens of service age. Nor is it likely that unit costs of weapon systems will decline. With each new generation of systems, requirements are generated for improvements to; increase efficiency in terms of kill probabilities, reliability, speed, range, etc., as well as to reduce vulnerabilities through armor protection, maneuverability, etc. Each improvement has generally been more costly than its predecessor. As indicated in Tables 8 and 9 there are many examples of increased performance at increased cost but few of equivalent performance at reduced cost. Despite an awareness of this propensity and a search for less expensive alternatives, which has been institutionalized with DOD, prudence dictates that the system as it now functions will survive through 1985.

If unit personnel and weapon system costs continue to increase, it appears that one or more of the following most plausible alternatives will eventuate:

- Defense spending will continue to increase in terms of current and fixed dollars.

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[1]Costello, "Debate on Defense Spending Grows," The Washington Post, p. L6 (28 April 1974).

Table 8

Higher Performance at Higher Costs

New/Old Weapon	Unit Cost	Payload	Range	Speed	Avionic Functions	OR&W Comfort and Safety	Weapon and Delivery Navigational Accuracy
F-15/F-14(54)	3X	1.0X	1.3X	2X	3X	3X	2X
A7/A-4(54)	2X	2.2X	1.8X	2X	2X	2X	3X
5-3/5-2(50)	7X	2.0X	2.7X	4X	4X	3X	3X
C-5/C-133(52)	5X	2.4X	2.1X	5X	5X	2X	10X
UTTAS/UH-1(59)	5X	5.5X	1.6X	2X	2X	7X	3X
DD963/DD710(42)	3X	3.1X	0.9X	2X	2X	2X	5X

Source: Fortune, December 1972, p. 146.

Table 9

Higher Performance at Lower Costs
(A Singular Exception: The LVTP7, Amphibious Assault Vehicle)

New/Old Weapon	Unit Cost New/Old	Difference	Payload New/Old	Difference	Range Land	Range Water	Maintenance Man Hrs/ 100 Miles New/Old
LVTP7/ LVTPS	129,000/ 146,000	-$17,000	25/34	-11*	300/ 190	70/70	6/22
New/Old Weapon	**Operating Cost per HR New/Old**	**Difference**	**Top Speed Land (MPH) New/Old**	**Difference**	**Water (Knots) New/ Old**	**Differ-ence**	**Track Life in Hours New/Old**
LVTP7/ LVTPS	40/70	-$30/Ar	41.6/30	+11.6mph	8/6	+2knots	600/200

* A negative comparison cited in source as an advantage in that more room is provided per man.

Source: Armed Forces Journal International, May, 1974, p. 21 as confirmed by G-4 Branch Headquarters Marine Corps.

- Present trends will reverse and defense will begin to consume a relatively larger share of the federal budget and will increase as a percent of the GNP in excess of 6, 8 or 10 percent.
- Acquisition of new weapons systems will slow. The evolution of performance of systems will also slow and will substantially lag behind technological capability in terms of speed, firepower, mobility, protective measures, responsiveness, reliability, etc.
- The size of the armed forces will be reduced from the current level of 2-1/2 million to 2 or even 1-1/2 million.
- Technological and conceptual breakthroughs will be produced which will provide equal or better operational capability for fewer dollars, with better systems and fewer men.

Two questions should be addressed here. First, what should be done and what contribution can RDT&E make to resolve the problem? The second question is, what will most probably eventuate?

As to what should be done, it appears fairly obvious that the most meaningful contribution that can be made through the use of RDT&E is to concentrate on the last possibility, i.e., search for the technological and conceptual breakthroughs which will maximize operational potential at less cost. The approach is not new within the DOD and there is every indication that efforts are being exerted to do just this. The scope of the problem is so broad, however, that it exceeds the limits of RDT&E influence as currently defined. If real economies are to be achieved, entire operational concepts must be reappraised, not only individual weapon systems, and this touches on Service prerogatives under law and jurisdictional sensitivities. There should be synergistic potential in the total force concept which has not been fully exploited. There may be a limit to the positive control military commanders and political authority may want to exercise over tactical units when the costs of such control become increasingly oppressive. Modern technology appears to offer potential for savings in unmanned versus manned weapon systems in aircraft and naval craft. The possibilities are unlimited. What is needed most is a well defined, authoritative strategy or policy framework which provides guidance for capitalizing on technological and conceptual innovations which could have far reaching effect on command

structure as well as hardware.

As to what will eventuate, any one or combination of the alternatives is plausible. From the perspective of 1974, it is too easy to speculate that the current trend will continue and, as a result, the armed forces will become much smaller with fewer new weapon systems at greater cost. But predictions based on only the economic factor are hazardous. There would be no consideration of the Soviet capability or intention as perceived by the United States, for example. There would be no consideration of the domestic political scene or such positions as those established by the House Armed Services Committee: "We reject the idea of ceilings based upon our projection of their recruiting capability."[1] However, from the perspective of 1974, considering the momentum of spiraling costs of new weapon systems and the current level of expense for manpower, the safest bet is that even with some modest increases in real expenditures, the size of the armed forces will diminish and that weapon system acquisition will more and more lag behind technological potential. Technological and conceptual innovations may moderate this trend; nevertheless, they should not be relied upon to reverse what appears to be the powerful momentum toward more expensive unit costs of weapons and manpower. The challenge therefore seems to be how to get more security from smaller armed services -- not as a matter of convenient economy but as a matter of economic necessity.

Despite its vulnerabilities, the United States has great relative economic strength and potential. While optimism must be guarded and recognizing that no nation is guaranteed continued superiority in any area, the prospect for continued economic strength, as an integral part of the security of the United States and relative to the remainder of the world, is good.

In 1973 the United States scored its first balance of payments surplus in a period of four years. The United States is and will probably continue to be competitive in the world market. Some of the advantages which accrue to the United States in this competition are:

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[1] House of Representatives Report No. 93-1035 to accompany HR 14592, p. 68 (10 May 1974).

- Less dependence upon foreign oil than most other mercantile, industrialized nations of the West
- A relatively sound position in international monetary forums which have historically moderated international systems
- A modern, agressive international marketing system for the sale of U.S. goods
- A slower rate of inflation than the majority of other world economies[1]
- Far greater resource independence (ores, oil) than trade competitors such as Japan and the Federal Republic of Germany
- Agricultural opulence over the short term and at least sufficiency in the long term
- Less dependence on total world trade (about four percent of GNP) than France and Japan (12 percent) or Germany and the UK (16 to 17 percent)[2]
- The world's most advanced technological base and technological potential
- Recent sobering, enlightening experiences with the Soviet Union in grain sales
- A relatively sound domestic economy.[3]

The big question in trade is the impact that foreign oil requirements will have on balance of payments for the United States and its allies. The outlook is not good and what is presented here as a relative advantage could be a substantial vulnerability if the United States does not conserve scarce energy resources and does not rapidly develop alternatives to foreign oil. It seems too obvious to dwell on the even more critical vulnerabilities of our allies and the interdepecence of the security as well as economic systems of the United States with NATO countries and Japan.

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[1]For the 12 month period ending in April 1974, the U.S. inflation rate was 10.2 percent, for Germany 7.2, the Netherlands and Norway 8.9, Switzerland 8.7, Sweden 9.4, Canada 9.9, however most other countries, Japan, Australia, France, Italy, the UK, included, had a higher inflation rate than the U.S. Source: Carl Rowen, Washington Post, p. A-19 (27 June 1974).

[2]Charles L. Schultze, "The Economic Content of National Security Policy," Foreign Affairs Quarterly, p. 536 (April 1973).

[3]Many of the advantages listed here are paraphrased from: Data Resources, Inc., Problems and Prospects for the U.S. Economy: Data Resources Long-Term Projections (1974-1985), pp. 99, 100.

There is a chicken and egg tautology in relating national security to economic well being. Certainly the two are interdependent. With a healthy economy we can better support a far reaching national defense program that extends a protective umbrella over Japan and Western Europe. The defensive capability in turn promotes and protects the environment necessary for continued economic growth. Both the economic and defense sectors draw from the same well of research scientists, technology oriented industries, government laboratories, universities and independent research organizations. All of these resources depend upon a healthy economy and a healthy economy must be physically as well as fiscally secure.

The fortunes of U.S. geography contribute substantially to the physical security of the U.S. economy. As previously stated, the great bulk of U.S. raw material requirements are either available within the United States or within the Americas. With no hostile threat at any immediate border, military resources need not be diverted to perimeter defense. Industrial complexes may be positioned at sites of greatest economic utility rather than for reasons of physical security.

The GNP is a useful index for sensing the health of the nation's economy. GNP relative to our principal adversary, the Soviet Union, is more so. Some long-term U.S.-USSR projections of GNPs are provided in Table 10. The statistics project a relatively secure economic picture for the United States. However, there are many imponderables ahead, any one of which could change this picture dramatically. The most obvious imponderable is, of course, energy. While the Table 10 forecast has been adjusted for energy and related economic traumas there is ample justification for arguing that given other, more pessimistic assumptions, a zero U.S. GNP growth could be justified. This Table 10 projection is more tempered. While it does present a reduced rate of growth (from 4.1 percent prior to 1973 to 3.4 percent between 1985 and 1995), it still assumes a healthy economy.

How can security policy be formulated to contribute to the maximization of U.S. strengths and to minimize vulnerabilities? The question is not difficult to answer when the reply is restricted to generalities. The difficulties arise in translating those generalities into practical programs for action. The following policy strategies are intended to go a step

Table 10

U.S.-USSR GROSS NATIONAL PRODUCT, 1950-1990
(In Terms of Billions of U.S. Dollars)

YEAR	U.S.	USSR	ABSOLUTE DIFFERENCE	USSR as % of U.S.
1950	503	164	339	32.6
1955	620	236	384	38.1
1958	633	288	345	45.5
1960	690	311	379	45.1
1962	750	353	397	47.1
1965	874	414	460	47.4
1968	1001	497	504	49.6
1969	1028	511	517	49.7
1970	1023	551	472	53.9
1971	1050	570	470	54.3
1972	1145	N/C	N/C	N/C
PROJECTIONS				
1974	1236	662	574	53.6
1976	1334	727	607	54.5
1978	1440	797	643	55.3
1980	1548	872	676	56.3
1982	1664	951	713	57.2
1984	1788	1035	753	57.8
1985	1852	1079	777	58.3
1990	2189	1320	869	60.3

Approach--The 1950-1972 statistics are derived from: Department of Commerce Report, "U.S. Soviet Commercial Relationships in a New Era", August, 1972, p. 30. The U.S. projections from 1974-1995 are based upon Data Resources, Inc. (DRI) prediction of growth potential for U.S. GNP as follows: 1973-79, 3.9%; 1978-83, 3.7%; 1983-85, 3.6%. (Data Resources, Inc., "Problems and Prospects for the U.S. Economy: Data Resources Long-Term Projections, 1974-1985," May, 1974, p. 5.) The DRI report adjusted growth potential for energy, pollution control, auto conversion, etc. The 1985-90 projection was made at a 3.4 percent estimate of growth potential for U.S. GNP. The 1974-1990 projection for USSR GNP is based on a least-squares fit of the linear transform of the hyperbolic function y=A+(B/x). N/C indicates "not calculated".

beyond the very general shibboleths with which any student of national security is already familiar but, admittedly, they fall short of the detailed action program required to promote a realistic economy of force or maximum protection for U.S. economic essentials. The strategies do not include personnel management techniques which might be used to more effectively employ manpower assets such as reducing personnel pipelines, promoting unit stability, etc. The list merely supplies a number of possibilities that appear to show enough force structuring a promise to warrant further study.

- Reduce expensive manpower requirements through one or more of the following approaches:
  - Operationalize the total force concept more vigorously to draw maximum benefit from interservice cooperation, allied forces and U.S. reserves and national guard. There is ample slack and possibilities in this area to effect economies. Air Force potential for coastal surveillance in ASW operations in support of the Navy is a possibility which is being pursued and should be continued.
  - Revise the Unified Command Plan to reduce the number of overseas area Headquarters through consolidation and reductions.
  - Revise the Service grade structure to reduce the officer to enlisted, senior to junior grade ratios.
  - Decentralize authority by providing general purpose force commanders more mission-type orders and reduce the degree of higher headquarters and political supervision. Reduce command, control and communication requirements proportionately.
  - Concentrate on research and development programs which promise manpower economy systems such as pilotless aircraft, unmanned submarines, automatic communication systems and greater fire power for the individual soldier.
  - Evaluate all proposed and existing weapon systems against stringent personnel economy indices in life cycle costing programs.
  - Make much broader use of automated systems on naval vessels to reduce manning requirements.
  - Achieve higher combat and combat support to combat service support ratios by
    - -- emphasizing modular replacement repair and maintenance techniques.
    - -- emphasizing producer-to-user pipelines
    - -- early retirement of obsolete equipment

-- substituting mobile maintenance and repair units for in-place, organic capabilities
-- emphasizing development of expendable weapon systems.

- Adopt a force structure for defense of those sea lanes of communication which analysis indicates:
  - Are essential to national security
  - Have no effective alternatives from other, more secure sources or modes of transport.

- Be structured for early rapid deployment in sufficient strength to defend principal sources of critical materials (e.g., the Middle East, Jamaica, Latin America)
  - Forces must be structured so that they are deployable in joint task force packages of varied sizes and capabilities to provide authorities the broadest possible choice of force
  - Sufficient surface and strategic lift must be available to move forces into objective areas
  - The entire system must be responsive to an automated deployment reporting (DEPREP) type discipline to facilitate organization, and training of forces as well as the conduct of contingency exercises for transportation operating agencies and senior headquarters.

- Continue to pursue mutual strategic force limitation negotiations with the Soviet Union to search for strategic arms reductions without prejudice to national security.
  - Meaningful strategic arms limitations could create new force requiremetns such as verification satellites or similar mechanisms. However, on balance, negotiations are currently the greatest potential source for achieving economies.

III GEOPOLITICS & MILITARY TECHNOLOGICAL IMPLICATIONS

> Particularly in the area which has been at the origin of so much nonsense: the geographical milieu, the "compelling" character of the environment has been much too easily assumed. The relationship between man and milieu is not one way.[1]

The contempt Stanley Hoffman expresses here is reserved for the deterministic aspects of geopolitics -- the convictions once expressed by the early disciples that geography determines the course of foreign policy and national strategy. Environmental determinism no longer seems to enjoy much favor among serious scholars of geography:

> The battle over environmentalism was fought, and won at least in principle, a generation ago within the discipline of geography. No geographer known to us would today endorse the environmentalistic rhetoric that still clutters the literature of politics, especially international politics. In recent years, geographic theorists have repeatedly asserted that environmentalism is a dead issue no longer worth debating.[2]

As portrayed by the Sprouts, there are still unwitting advocates of such determinism writing contemporary political and military analyses however. Such modern day strategists theorize on such matters as the 'dominance of the island chain which circumscribes Pacific Asia,' or 'the mountains of Japan have pushed the Japanese out upon the seas . . . sea routes have beckoned the Japanese . . . the factor of geographic isolation during the past two thousand years has helped fashion national traits which eventually and almost inevitably led Japan to political isolation and to crushing defeat in war.'[3]

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[1] Hoffman, Contemporary Theory in International Relations, p. 173, (New Jersey, Prentice-Hall, Inc., 1960).

[2] H. and M. Sprout, The Ecological Perspective on Human Affairs, p. 80 (Princeton, Princeton University Press, 1965).

[3] E. O. Reischauer, "Japan: Past and Present" (Knopf, 1946) pp. 5, 8, as quoted in Sprout, op. cit., p. 72.

There are other reasons why geopolitics has fallen into disrepute, including its association with "military thought" and allegations of its lack of anticipating or accommodating the technological impact on how we cope with geography. Derwent Whittlesey has described geopolitics in a pejorative sense as "a creature of militarism and a tool of war."[1]

Geography is a "science that deals with the earth and its life," including "the description of land, sea, air, and the distribution of plant and animal life including man and his industries."[2] Geography enjoys a great deal more general acceptance than does geopolitics. Robert Strausz-Hupé has described it as a discipline which provides a bridge between the exact sciences and nature and the rather inexact sciences of man and indicates that it "seems to have rid itself of the last century's determinist philosophies much sooner than the social sciences. For a long time, geographers have conceded to environment the power to condition, but not to determine the economic and political evolution of society."[3] Defense planning guidelines should accommodate and support the strategy and tactics which are derived from many considerations, not the least of which is military geography.

This section deals with a subject whose scope is much narrower than geopolitics but broader than geography. For this purpose the concept of geography is extended to include space. While the impact of space on military tactics and stracegy is uncertain in 1974, the potentials cannot be ignored. This paper is written with the view that in the future, the terrestrial milieu will continue to be most important in matters of national security,[4] as will surface maritime and air considerations, however,

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[1]Derwent Whittlesey "Haushofer: The Geopoliticans" in E.M. Earle, ed., Makers of Modern Strategy, p. 389 (Princeton University Press, 1944).

[2]Webster's New Collegiate Dictionary (Massachusetts, G&C Merriam Company, 1973).

[3]Stausz-Hupe', Annals of the American Academy, p. 170, Vol. 369.

[4]The continuing importance of land warfare in this age of high technology is attested to by Dr. Malcolm R. Currie, Director of Defense Research and Engineering in his 26-27 February 1974 statement before the Senate Armed Services Committee: "In the end, battles are won or lost and territory held or given up by individual soldiers" (pp. 1-23).

increasing emphasis and concern will be (or should be) given to subsurface maritime and space operations.

Terrestrial considerations of military geography imply land armies and the airpower to permit them to survive on the battlefield and to provide them with offensive support. The principal area of concern for configuring land forces and supporting air in 1974 is Europe. The U.S. commitment to Europe was restated in 1972 and 1973 by President Nixon:

> In light of the present strategic balance and of similar efforts of our allies, we will not only maintain but improve our forces in Europe and will not reduce them unless there is reciprocal action by our adversaries.
>
> This pledge rests on a fundamental view, as valid today as it has been since World War II, that the security of Western Europe is inseparable from our own.[1]

There could be a shift of emphasis from defense of Europe to Asia or the Middle East but it seems unlikely. Prudent long range general purpose force planning should continue to focus upon Western Europe -- but not to the exclusion of other potential areas of operation. The locus of concentration can be further focused upon West Germany which forms the frontier of the NATO-Warsaw Pact confrontation.

The Federal Republic of Germany (FRG) has a population of 59.6 million in an area of 95,727 square miles for a density per square mile figure of 620.8.[2] It ranks second only to Japan in terms of population density among the top 26 most populous countries of the world -- ten times as dense as the United States. While it ranks tenth in the list of most populous countries of the world, in terms of area it is not listed in the top 26. The annual increase in population based on the period 1963-1970 was 1.0 percent (one of the smallest of the most populated countries but larger than the U.K., Italy, and France). Postulating a straight line projection to the year

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[1] Richard Nixon, U.S. Foreign Policy for the 1970s, Shaping a Durable Peace, Vol. IV, p. 84 (3 May 1973).

[2] Based on 1972 figures from The Official Associated Press Almanac, 1974.

1995, with no changes in present national boundaries, West Germany would have a population of about 75 million (a 26 percent increase) with a square mile population density of 783.5. This projected density exceeds the 1972 population density of Japan which currently has the highest percentage in the world. The population of the FRG is predominantly urban and is becoming more so. About 20 percent of its citizens currently live in the eleven largest cities with three of those cities over 1 million. About 30 percent of the area is under cultivation, it is relatively rich in minerals and includes one of the most productive industrial bases in the world, the Ruhr. The port complex on the North Sea (Bremen and Hamburg) is one of the world's busiest.

A detailed analysis of the military geography of Western Europe is contained in a Stanford Research Institute Memorandum published in 1964.[1] This section of Module I will rely in part upon the 1964 analysis which still appears to have contemporary value in relation to the Central Front of Europe. The analysis identifies, inter alia, the following major East-to-West avenues of approach into Central Europe:

- The Czecho-Germany approach (see map No. 2)
- The Thuringian Gap (Fulda Gap) (see map No. 3)
- The Thuringia, Franconia, Saxony approach (see map No. 4)
- The Hamburg Glacis (see map No. 5)
- The Central Sector (see map No. 6)[2]

There are other good possibilities of critical avenues of approach within and outside of Central Europe. There is the approach through neutral Austria described by the former Czechoslovak Major General, Jan Sejna, in December 1973.[3] There are the vulnerable flanks of NATO, particularly the Danish

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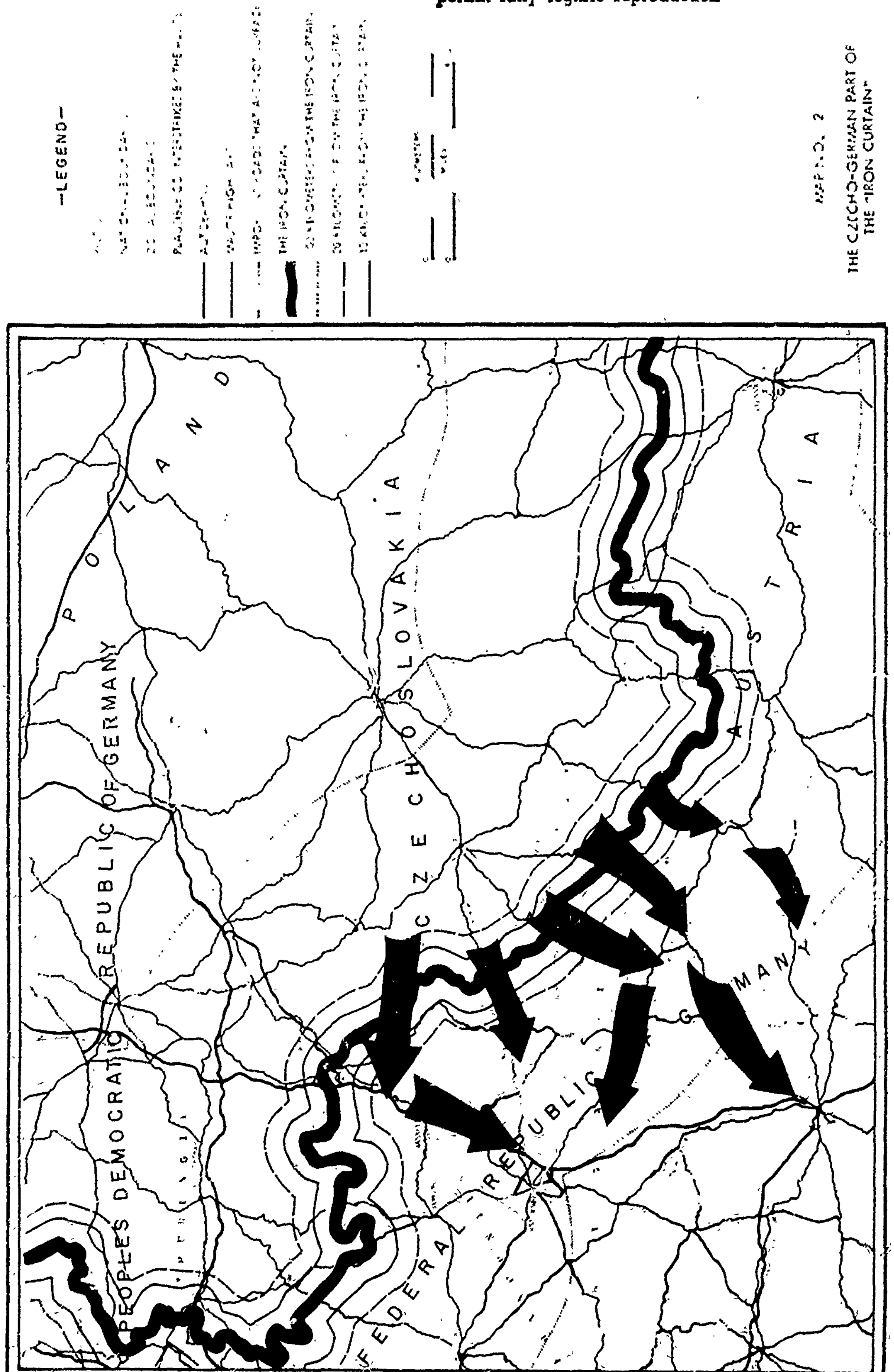
[1] R. B. Johnson and E. L. Heckler, An Atlas of the Arms Control Context and the Disengagement Concept for the Europe of the 1960's, (California, Stanford Research Institute, SRI Project 4468, January 1964.

[2] Ibid.

[3] Major General Jan Sejna, former CSSR Army on Vienna Domestic Television SService First Program in Germany 2015 GMT (20 February 1974).



MAP NO. 2
THE CZECHO-GERMAN PART OF THE "IRON CURTAIN"

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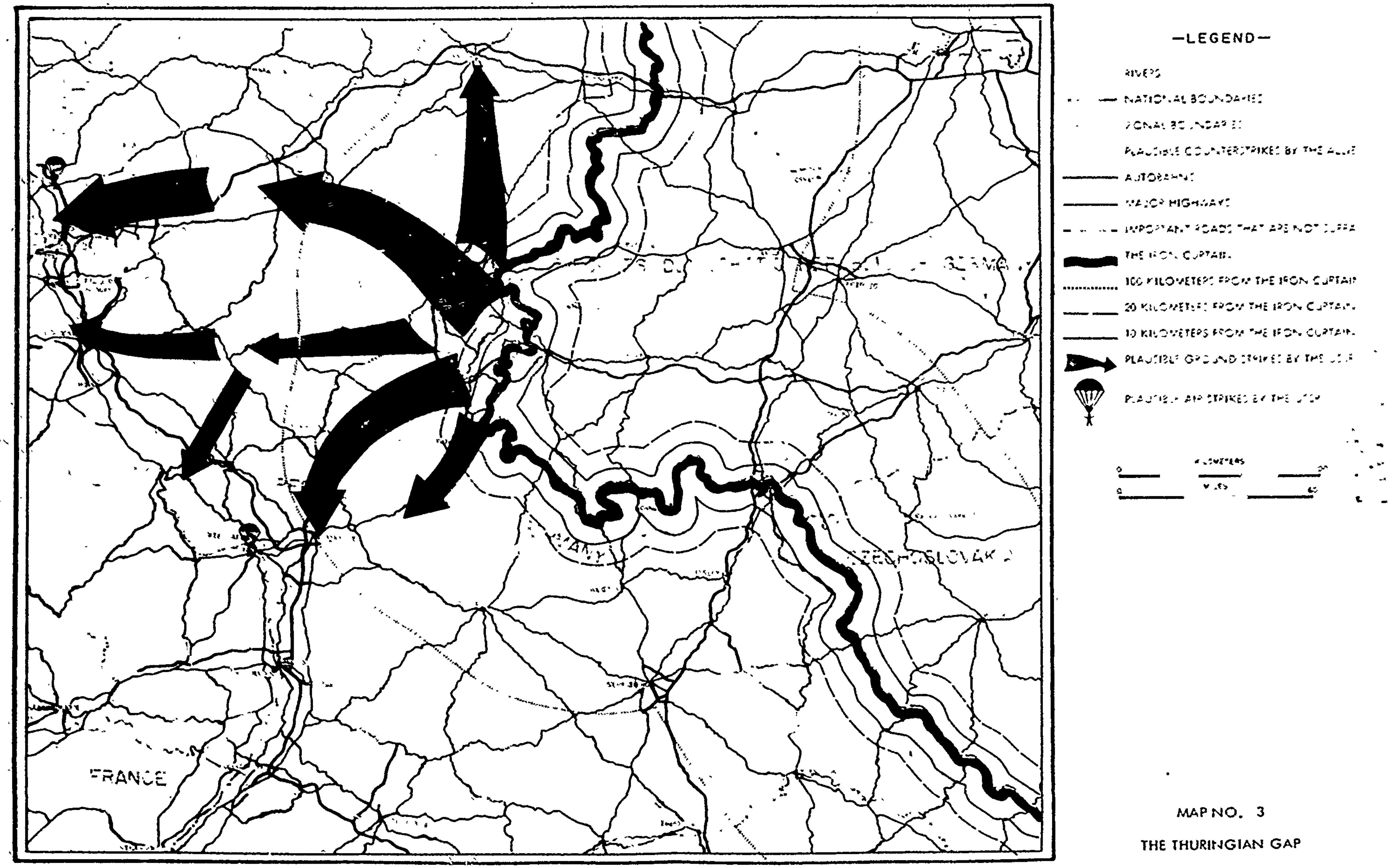

MAP NO. 3

THE THURINGIAN GAP

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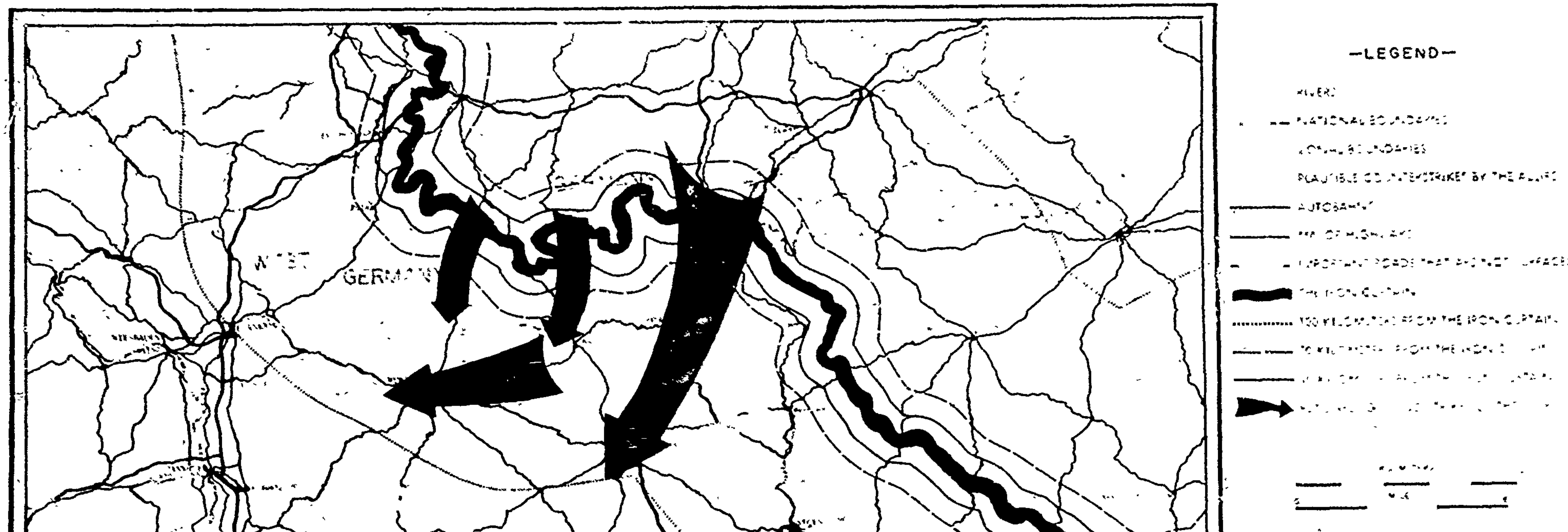

MAP NO. 4

THURINGIA, FRANCONIA,
AND SAXONY

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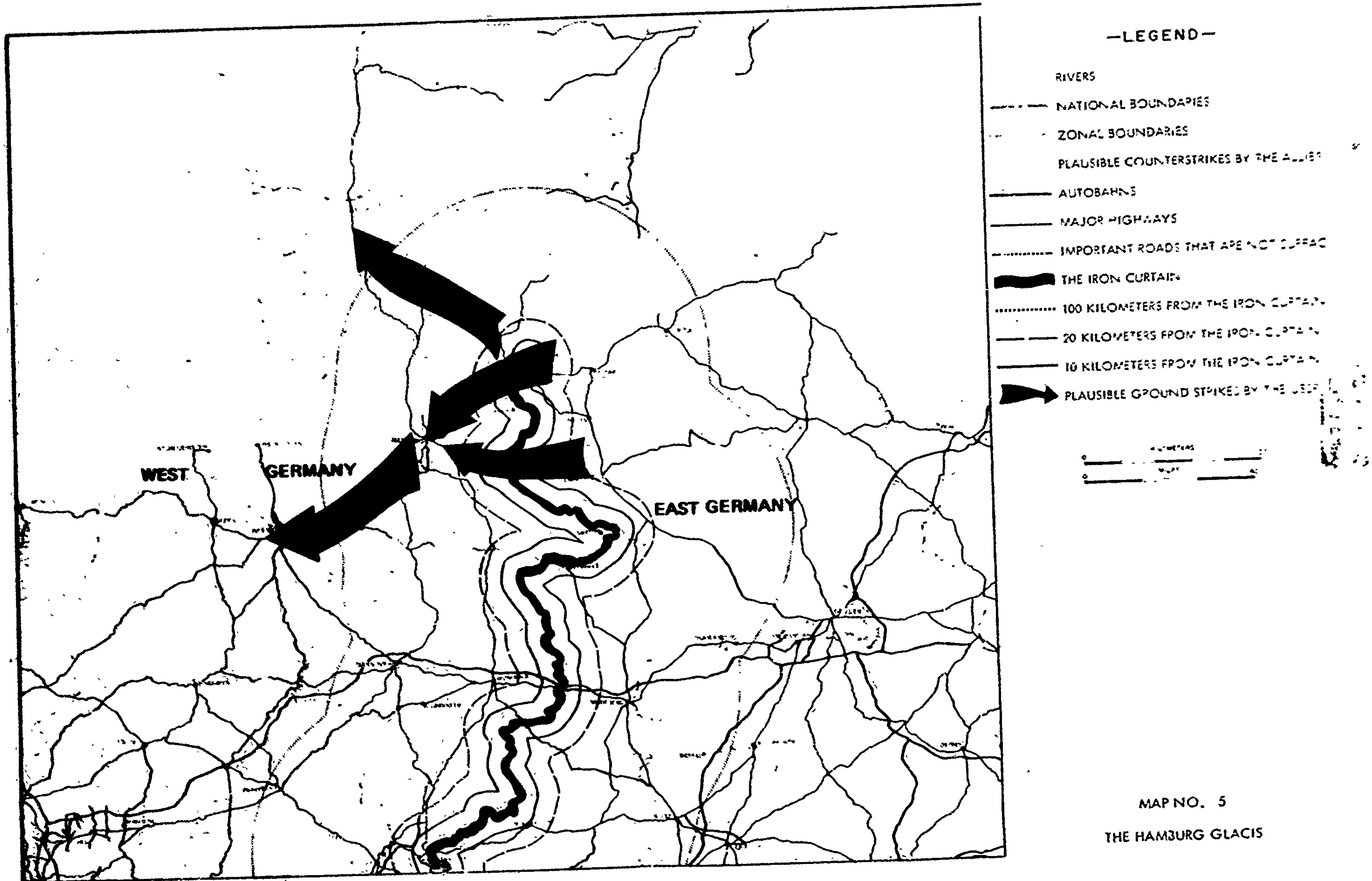
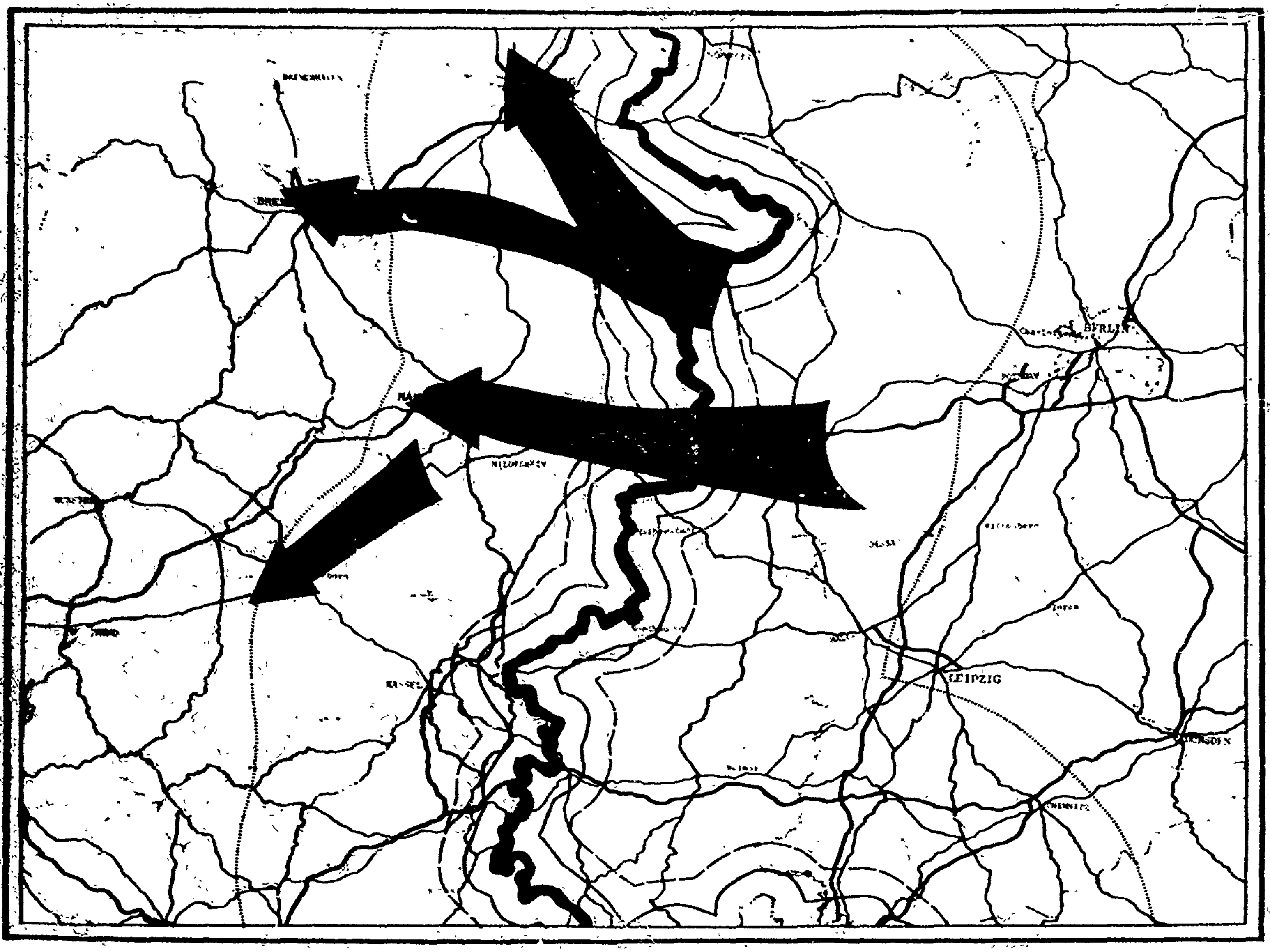
permit fully legible reproduction



MAP NO. 5

THE HAMBURG GLACIS



—LEGEND—

PLAUSIBLE COUNTERSTRIKES BY THE ALLIES

THE IRON CURTAIN

100 KILOMETERS FROM THE IRON CURTAIN

25 KILOMETERS FROM THE IRON CURTAIN

IMPORTANT ROADS THAT ARE NOT SURFACE

KILOMETERS 0 100

MILES 0 60

MAP NO. 5

THE CENTRAL SECTOR

Straits, Norwegian Finnmark in the North, and the Thrace, Turkish Straits area in the South. However, of all of these potentials, the one which, considered in conjunction with Soviet armor capability, should probably have the greatest impact on U.S. force structure is on the Central Sector (map 6) across the German plains. Many scenarios[1] envision a blitzkrieg attack through this sector which would push rapidly to the Ems-Weser line and the Rhine. There are several good reasons why a blitzkrieg attack in the area may not be a prudent course in 1985. First, there is the thorough compartmentation of the area by a series of water obstacles which may be easily defended. (The counter to this argument, of course, is the excellent Warsaw Pact bridging capability demonstrated so vividly in the October War and the historical precedents of successful campaigns of some of the great captains of history. On the balance, however, even with superior bridging capability and the historical precedents, the Northern plain presents serious problems for armored forces.) The second reason why a 1985 blitzkrieg attack through this area may not be prudent is the growth of the German population and the urbanization trends cited earlier. Today this area is principally devoted to agriculture and, for Germany, has a relatively low population density. By 1985, however, population growth and urbanization could substantially restrict what is currently fair to good mobility for armor forces. Throughout Germany, successful tactics may require a force equipped to fight in towns and cities rather than in tank columns across open country. Nevertheless, the principal clue to a proper force structuring of U.S. forces to fight in this most critical area of U.S. commitment does not lie in the question of the best strategy for the Soviets from the U.S. perspective. The determinant is, rather, what is the Soviet capability and (to the extent to which it may be gleaned) intention? Given the Warsaw Pact to NATO main battle tank force ratio of 17,000 to 6,500[2] and what is currently known of Soviet land warfare tactical and strategic predictions, the best guess is that a 1985 armored attack across the German

[1] The Martin-Marietta "Barbarossa" scenarios apply here.

[2] The Military Balance, 1973-1974 (International Institute for Strategic Studies, London, 1973), p. 90.

plains is as good a scenario as any for long range force planning. The significant consideration in this very brief analysis, however, is that due to population growth, urbanization and the geographic compartmentation of this area, such an attack may be much easier to counter in 1985 providing NATO's forces are structured and trained to do so.

Forces should be structured to maximize antiarmor capability. This does not necessarily imply another armored force notwithstanding the adage that the best defense against a tank is another tank. Emphasis upon systems and organizations which provide a high degree of mobility and firepower should have research and development priority over those which emphasize armor protection. An inventory of earth-penetrating nuclear artillery rounds would avoid many of the political and tactical objections to pre-chambered ADMs and could selectively enhance the natural terrain barriers of Western Germany in a timely manner. NATO force organization should be so structured that it avoids the restrictions imposed by highly compartmentalized terrain and fighting in built-up areas. It appears that armor as we know it now does not fully satisfy those requirements. Requisite mobility and antitank firepower appear to be most promising. The force structure should give high priority to fixed and rotary wing aircraft equipped with precise, guided weapon systems with ranges which will permit standoff engagements. Given the density of population and the projected urganization of West Germany in 1985, the prospects of fighting tanks in built-up areas are good. Airborne weapon systems would appear to have limited application in such circumstances unless we are prepared to destroy the cities. Infantrymen, therefore, may not be able to rely upon air support in such operations. They should be equipped with a light, mobile organic antitank capability which possesses the same one-shot, one-kill probabilities of the aerial systems. They should be organized and trained to employ such weapons at the small-unit level with relative independence from senior unit direction. They should have both a standoff and close-in antitank capability. Much has been written of the priority requirements for good identification, friend or foe (IFF), battlefield surveillance, target acquisition and control systems -- they are all essential to both air and ground antitank systems.

The foregoing provides rought parameters of force guidelines for defense in Europe. The parameters give priority to mobility and discriminating, precise firepower over armor protection and massed destructive fires within the FRG. Massed fires may be required forward of the FEBA and forces should be organized to deliver such fires; however, the expectations are that they may have limited utility at the line of contact within friendly areas. Aerial interdiction missions should continue to enjoy high priority for planning purposes.

Historically, the principal concern of maritime geography has been sea lines of communication (LOCs) and projection of naval power ashore to control the land areas which dominated such LOCs. Mahan, for example, focused on "sea-transported power" and his interpretation that "control of the sea could only be achieved by controlling those land bases that had the advantages of strategic location, coastal shape and defensive depth to their hinterlands."[1] With the advent of naval aviation and the ballistic missile submarine concepts of naval power have been extended to the strategic dimension of nuclear war. We are undoubtedly on the threshold of another dimension, the subsurface to seabed realm of the continental shelf and abyssal plains. The following two areas will be discussed in relation to the impact of geography (oceanography) upon the structure of U.S. forces in 1985:

- Sea lines of communication
- Subsurface oceanic environs

In 1942, Bernard Brodie made the following appraisal of the significance of seapower in relation to sea lines of communication. The statement is illuminating because it seems at once both so right and so wrong:

> All naval enterprise -- with the exception of bombardments of land objectives from the sea, which is only an incidental use of sea power -- is directed toward the single aim of affecting the movements of the lowly freighter or transport in which is carried nearly all the commodities and the men

[1] S. B. Cohen, Geography and Politics in a World Divided, p. 48 (New York Oxford University Press, 1973).

> that move across the sea. If in the future the greater part of ocean transport is carried in aircraft rather than in ships, or if the transfer of men and commodities across the seas becomes unimportant sea power as such will cease to have meaning.[1]

Brodie's statement was not entirely correct even in 1942.[2] In 1974 we find he has been disproved because the development of the ballistic missile submarine has provided a strategic dimension to naval forces which could survive long after a degradation in the importance of sea lines of communication. In 1974 we do find that the transfer of "men across seas" has become less significant. We find that at least the initial combat unit reinforcement of Europe in time of crisis will be made by air as provided in Reforger and Crested Cap plans. However, the main thrust of Brodie's thought seems as valid today as it was in 1942 -- that is -- the security of sea lines of communication is absolutely essential for a nation such as the United States and a principal objective of our fleets is to provide such security. In terms of overall U.S. priorities:

> The Nixon Doctrine . . . recognizes defense priorities in the following order of importance: first, continental defense; second, protection of lines of communications; third, maintenance of alliances; fourth, protection of U.S. overseas interests; and fifth, the capability to assist indirectly or directly in local conflicts, if, when, and where advisable.[3]

The great bulk of all materials shipped to Vietnam during that conflict went by sea. Admiral Moorer, then Chief of Naval Operations, was quoted in 1970 as saying:

> Our country is an island bounded on each side by oceans which are our major avenues for trade with the rest of the world. Although we are a nation blessed with abundance of many natural resources, we cannot forget

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[1] B. Brodie, A Layman's Guide to Naval Strategy, pp. 4, 5 (Princeton, Princeton University Press, 1942).

[2] He failed to recognize projection of naval power ashore in amphibious and air operations.

[3] C. Hosmer, "The New Geopolitics," United States Naval Institute Proceedings, p. 21 (August 1973).

> that we depend on no less than 66 strategic material imports . . . .There is no economic viability of this country which does not include our free use of the seas . . .[1]

Moorer's relief, Admiral Zumwalt, predicted that by 1985, the United States will need to import some 12 million barrels of oil per day. Such import requirements (which could be substantially reduced by those programs recently initiated to achieve energy independence) would, according to Zumwalt, require from several hundred to over 1,000 tankers.[2] The following considerations seem to be central in assessing the significance of sea lines of communications in 1985:

- Today's supply routes across the oceans will continue to be important to the security of the United States and its allies in 1985. In 1974 the United States is "a net importer of every strategic metal except copper."[3] Forty percent of Japan's internal commerce is transported over ocean waterways.[4] The advent of the cargo airplane has not diminished seaborne commerce. To the contrary, the world's seaborne trade nearly doubled in the 1960's.[5] One expert predicts that by the year 2000 the United States alone could be carrying the same volume of seaborne tonnage (about 2.5 billion tons) annually as is carried today by all ships of all flags in the total world trade of all nations.[6] Transporting men to reinforce Europe or the Pacific by air is a relatively simple task assuming that the U.S. controls the air and that aerial ports are intact and adequately manned. However, in a prolonged conflict, transporting supplies and equipment and resupply and materiel replacements by air are

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[1]Thomas H. Moorer cited by Norman Polmar in "The Navy and the Nation: Approaching the 'Final sands'?", Sea Power (October 1973).

[2]Elmo R. Zumwalt cited by Michael T. Klave in "Defense Puts Out to Sea," The Nation, p. 10 (2 July 1973).

[3]Yuan-li Wu, Raw Material Supply in a Multipolar World (National Strategy Information Center), p. x (New York, Crane, Russak & Company, 1973).

[4]P. Cohen, "New Roles for the Submarine," United States Naval Institute Proceedings, p. 36 (September 1972).

[5]Captain E. F. Oliver, USCG, "Gargantuan Tanker Privileged or Burdened?" U.S. Naval Institute Proceedings, p. 45 (Septem er 197[illegible]).

[6]I. M. Heine, "Dragging Anchor--or a Future of Tremendous Growth?" Sea Power, p. 33 (April 1973).

today, and will be in 1985, a physical impossibility in terms of the magnitude required for the defense of Europe or our Asian allies. An Army cynic has been quoted as saying "with the C-5 they can put us anywhere in the world overnight--and we will starve to death on the end of the pipeline".[1] There are some possible alternatives to surface shipping as we know it today. Lighter than air craft have many of the same advantages and disadvantages of surface ships--they could be exploited for commercial use.[2] Under-water transport is another possibility. Nevertheless, despite all the imponderables involved in projecting into the future, one forecast which seems to be safe is that by 1985 the U.S. and its allies will continue to rely heavily upon surface sea lines of communication for commerce and military purposes in times of peace, crisis and war.

- The geography of these supply routes will continue to restrict and threaten free movement of shipping of the U.S. and its allies. There are 116 major straits and two major canals[3] which dominate the sea lines of communication across the world. The actual or potential impact they leave on the free movement of commerce in peace and wartime reinforcement and resupply vary substantially. One of the most critical of these choke points is the Malacca straits which provides an excellent example of the far reaching effect geography can have upon the security and economic well being of a nation. (In fact, there are two straits off the Indonesian Archipelago, the Singapore Strait and the Malacca Strait which we group together under the name of the latter.) It is about 500 miles long with the governing depth of water about 12 fathoms. Ninety percent of Japanese lifeblood, oil, comes from the Persian Gulf. Such ships which do

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[1]Colonel F. B. Case, U.S. Army "The Versatile, Vulnerable Container Ship," United States Naval Institute Proceedings, p. 50 (February 1972).

[2]It would take many blimps to equal one supertanker, however. If we assume that the average supertanker has a capacity of about 200,000 long tons with the lifting capacity of helium at 70 pounds per 1000 cubic feet, it would require a volume of about 7 billion cubic feet of helium to lift the cargo of the single supertanker. Such equates to the capacity of about 1,000 Hindenburgs. (Source: R. E. Weston, New York Times, Letters to the Editor, 27 March 1974.)

[3]There are actually 19 major world ship canals, but, only two, the Panama and Suez, are important for our purposes.

not use the Malacca Straits would probably use Lombok or Sunda Straits to the south which adds another 1200 miles to their route. Both of these alternative southern routes are also dominated by the Indonesians. In 1957 President Sukarno declared that all waters lying between the islands of Indonesia ". . .are natural appurtences of its land territory" and therefore subject to total Indonesian sovereignty.[1] To avoid those straits dominated by Indonesia, large ships of the size of Idemitsu Maru, a Japanese supertanker and USS ENTERPRISE (CVAN-65)[2], would be [illegible]rced to transit South and East of Australia to reach the South China or Philippine Seas. Such a routing would increase the Japanese round trip to and from the Persian Gulf by 14,400 miles or by a distance which is double the route through the Malacca Straits. Should the Straits lying within the Indonesian Archipelago be closed to either U.S. or Japanese surface shipping, it would have substantial impact on the economic well being of the latter and the strategy and security of the former.

- <u>Events relating to economics and technology are continually transpiring which change our perspectives of the vulnerability of surface shipping in wartime operations</u>. Two of the most significant developments in the time of the drafting of this paper is the U.S. recognition of the extent of the energy crisis and the embargo of oil from the Middle East. The crisis has generated a U.S. policy to seek self-sufficiency by 1985, within the time frame of this paper. To do so, within the next eleven years, would have a subst[illegible] upon the amount of U.S. shipping which would be [illegible] Admiral Zumwalt's estimate of a requirement fo[illegible] sail from several hundred to over 1000 tanker[illegible] stated. However, to meet even a ninety perc[illegible] sufficiency by 1985 would, according to Dr.[illegible]

  - Domestic crude oil production -- a 37 pe[illegible] over the 1970 rate.
  - Domestic gas production -- a 37 percent increa[illegible] the 1970 rate.

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[1] Captain Richard A. Miller, USN, "Indonesia's Archipelago Doc[illegible] Japan's Jugular," <u>U.S. Naval Institute Proceedings</u>, p. 27 (Octob[illegible]

[2] The Idemitsu Maru (one of the smaller tankers at 150,000 tons drawing 55 feet of water) is cited here because it scraped bottom going through the Straits. CVAN-65 is cited because of the stir created by its transiting the Straits during the Indian-Pakistani War of 1971. (Source: Captain Edward F. Oliver, USCG, "Malacca: Dire Straits," <u>United States Naval Institute Proceedings</u>, pp. 28-29 (June 1973).)

- Domestic coal production -- a 176 percent increase over the 1970 rate.
- 435 additional nuclear power plants, each with a capacity of one million KW.
- 8 shale oil plants, each with a capacity of 100,000 barrels a day.
- 13 oil-from-coal plants, each with a capacity of 50,000 barrels a day.
- 30 gas-from-coal plants, each with a capacity of 250 mm SCF/D.
- 19 geothermal plants, each with a capacity of one million KW.[1]

The magnitude of the effort resembles that of the Manhattan Project. However, Professor Wu is, on balance, optimistic and it would appear that by 1995 (if not 1985) the U.S. could be energy independent to a substantial degree (say 90%). Such independence will not relieve us of concern for the security of sea lines of communication, however. Other strategic materials must still be carried in ships to the U.S. Our allies (e.g., NATO and Japan) will probably still rely heavily on Persian Gulf oil. The wartime or crisis supply of deployed U.S. forces, operating on exterior lines, will require secure sea lines of communication. Providing security for such shipping may be complicated by the immense tankers and fast container ships being built and planned for construction. From 1956 to 1974 the largest oil tanker afloat has increased from 56 089 tons to 483,664 tons. The increase in eighteen years was a gigantic 762 percent. Of the ports in the world which can handle very large crude oil carriers (VLCCs), there are none in the U.S. As of 1 May 1973, there were 25 VLCCs over 280,000 tons and there are several being built which run to 533,000 tons. On 1 July 1972, President Nixon announced that contracts had been awarded for the construction of 16 new merchant ships to include six VLCCs. "The handwriting is on the bulkhead -- the 'Big Boys' (the VLCCs) are here."[2] The trend in cargo shipping is toward the fast (33 knot), big (41,000 gross ton), container ships to replace the antiquated break-bulk fleet of the U.S. while there are about 146 container ships with a capacity of more than 60,000 containers,[3]

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[1] Yuan-li Wu, "Raw Material Supply in a Multipolar World," op. cit., p. xi.

[2] Commander Bernard Frankel, USN (Ret'd), "Offshore Tanker Terminals: Study in Depth," U.S. Naval Institute Proceedings, p. 57 (March 1973).

[3] Case, "The Versatile, Vulnerable Container Ship", op. cit., p. 50.

five of them are in the gargantuan class of 41,000 tons.[1] These new classes of ships, both tankers and container ships, pose new and special problems for safeguarding our war sea lines of communication. Both are highly valuable and the loss or diversion of a single ship to the enemy could have a substantial impact on the capability to support deployed forces. The VLCCs remain slow, lumbering hulks, with speeds of 15 to 17 knots, with little capability to maneuver.[2] The only advantage the new tankers present in the area of vulnerability is that there would be many fewer to defend. The container ship presents more advantages. One analysis provides:

> At first glance, the new ships appear to have a major defensive advantage over World War II shipping. The few ships which could run at high speed in World War II sailed unescorted in relative safety. Container ships which can steam above 30 knots have already been built and the economics of container ship operations will continue to make high speed profitable. In the last 25 years, however, submarine performance has improved at least as much as cargo ship performance. Modern high-speed cargo ships will be safer than slow ships against modern submarines, but this is not to say they will be safe. Other ASW defenses are necessary to keep the sea lanes open.[3]

The subsurface of oceanic environs is a world of hyperbole. It is biologically the most densely populated area on earth, its waters contain every known element from chlorine to ten billion tons of gold, it includes one of the hottest areas in the world (Woods' Hole in the Red Sea--132.8 degrees farenheit) and has the greatest system of mountains on earth. There are a number of possibilities for technological and scientific developments which will impact on ocean environment and and which will change our perspectives of naval operations. One such potential is the fuel cell to provide electric power sources for underwater propulsion systems. Space

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[1] The World Almanac and Book of Facts, 1974, p. 119 (New York, Newspaper Enterprise Association, Inc., 1973).

[2] The stopping distance for the Idemitsu Maru is approximately 2.5 miles and takes 21 minutes. (Captain Oliver, "Gargantuan Tankers," op. cit., p. 41.)

[3] Case, op. cit., p. 52.

technology has provided valuable insights into such power systems and the possibility of building economical models in ten years is good, in twenty years -- excellent. Inertial navigation systems have been vastly improved and are becoming more economical and compatible to subsurface operations. Navigation satellites will soon be available to all shipping, military and commercial. Within the timeframe of this study, satellite systems could perform worldwide oceanic surveillance functions and provide the sensors for monitoring the movement of all the major craft in the world. The potential is not limited to surface transport but could include subsurface movements as well. It seems almost inevitable that exploration for oil and minerals on the continental shelfs will lead to extensive exploitation of those areas. However, there also appears to be great potential for mining and oil extraction from deeper waters. The possibilities imply a comprehensive system of underwater factories and storage and transport systems. Offshore oil and gas exploitation has become a fairly routine enterprise. Offshore mining of seabed manganese nodules, rich in copper, nickel and cobalt, is becoming so. The first aquatic city is planned to be completed off Oahu, Hawaii, by 1976. Such developments could well be the precursors of extensive offshore and deep-ocean complexes with airfields, processing plants and living accommodations for small company towns. The list of developments which apply to the underwater environs is endless and includes laser technology, aquaculture (fish farming), undersea robots, men equipped with artificial gills to permit fluid-breathing at 3,000 feet, trained mammal assistants (dolphins, sea lions, etc.), advances in metallurgy and life support systems from the space program, and long range communication techniques. The significant consideration here is how these developments may impact upon defense planning guidelines.

The physical security of the continental United States and those islands which were dependent upon the United States for security has, historically, been a rather simple task. The United States has been relatively free from the physical impact of war. There have been exceptions, the War of 1812 and the attack on Pearl Harbor in 1941 being notable. The development of the long-range ballistic missile and the ballistic missile submarine have changed this. The U.S. position has changed from one of insularity and

relative invulnerability to one of direct interface with our potential adversary and high vulnerability. Technology has wrought a change in geographic perspective and has driven changes in military force organization. Technology in underwater systems could well increase U.S. vulnerability in another dimension. As U.S. interests become more and more committed to deep ocean activities and are extended into international waters, the problems of providing security for such activities increase.

The fate of the submarine over the next twenty years is one of the principal concerns which must be examined if one is to look thoroughly at planning guidelines for 1985. The 1970 Strategic Survey described the key antisubmarine warfare (ASW) task as being "to 'hear' submerged submarines at an adequate range, either by picking up the sounds they make or by bouncing sound waves off them and picking up the echoes."[1] The 1970 status of this submarine ASW competition was categorized as follows:

> The financial and technical effort devoted to ASW by both East and West is very great and seems to be increasing. The range of ASW techniques is very wide. Nevertheless, all the evidence suggests that the balance of advantage continues to lie with the hunted submarine.[2]

It is possible that by 1985 ASW operations will no longer be restricted to "listening" for adversary submarines. By this time ubiquitous space satellites could be watching or sensing their prey even while submerged. The last refuge of the submarine could, therefore, be under the polar caps, a much reduced area of operations which might be monitored by other sensor systems and attack submarines. A counter to such systems could be the remotely piloted, unmanned submarine which, in either a strategic or attack role could lie dead in the water for extended periods making use of the masking properties of the underwater terrain in seeking concealment from hostile satellites. The endurance of a submarine today is the tolerance of

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[1] Strategic Survey 1970, p. 14 (The International Institute for Strategic Studies, London).

[2] Ibid., p. 16.

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[1] Strategic Survey 1970, p. 14 (The International Institute for Strategic Studies, London).

[2] Ibid., p. 16.

the crew. Should the crew be removed, the endurance of the system could be extended indefinitely. Unmanned submarines, like remotely piloted aircraft, freed from the enormously expensive and space consuming life support systems, could be much smaller, faster, quieter, more efficient and economical and could run deeper (in excess of 10,000 feet).

In 1985 naval forces will still be organized to provide security to sea lines of communication protecting fewer but higher value (larger) ships. Defensive naval forces could be on the threshold of operating in flotillas of very fast surface ships such as the SES and twin-hulled ships and small carriers with vertical take-off fixed-wing aircraft. They could be assisted in their ASW role by an extensive satellite and submarine tracking system. Precision guided munitions in conjunction with improved surveillance and target acquisition systems could provide a one shot -- one target -- one kill capability. More and more it appears that naval warfare will be based on the contest between surveillance and countersurveillance tactics. Once a target is acquired its destruction will be practically assured through the employment of long-range, highly accurate, highly discriminating weapons. Naval forces could be organized for new missions to provide security of industrial enterprises which are projected well out into and under international waters. The British North Sea oil complexes, for example, are highly vulnerable and will require novel defensive measures.

<u>Space</u>

> Over the next two decades, applications of Space technology will be felt in all areas of human affairs -- economic, technological and especially geopolitical.[1]

In the three years since these words were written, Kane has been prov correct many times over. Space has had an obvious and pervasive effect on many aspects of human affairs. Better than half of the nations in the world are using satellites routinely in communication and weather programs. As Kane points out, over 90 percent of international telecommunications are

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[1] Francis X. Kane, "Space Age Geopolitics," <u>Orbis</u>, Volume XIV, Number 4, pp. 911, 912 (Winter 1971).

carried by communication satellites.[1] The Space Age has been a very expensive proposition for the United States but has produced great returns. One study[2] which has attempted to quantify the spin-off from our civilian space program cites expenditures of about $29 billion on civilian R&D between 1959 and 1969 which produced an estimated return of $56 billion through 1970 and credits a $207 billion return by 1987. In another estimate, benefits from the Earth Resources Technology Satellite (ERTS) Program alone are calculated to be $60 billion a year.[3] The Apollo fuel cell may be the breakthrough required to provide the next stage of propulsion for our ballistic missile submarines replacing the very expensive, complex and space-consuming nuclear powerplants. The same fuel cell may be adapted to provide energy for entire towns. The NASA Patent Abstracts Bibliography lists 1,892 NASA-owned inventions which are available to the public for licensing.[4] The technical data available are so voluminous and so sought after that NASA has established data banks and technology information centers throughout the country for commercial subscribers.[5] Space technology has had an impact on the world that is too pervasive to measure.

The current and anticipated impact of space technology on defense guidelines and the spin-off of values derived from military programs is harder to estimate but probably as significant. Many of the military programs are classified to include those which are most active. Satellite and Missile Observation System (SAMOS) has been wrapped in secrecy since 9 September 1961 when SAMOS III exploded on the pad.[6] The justification for secrecy in the

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[1]Kane, op. cit.

[2]By the Midwest Research Institute as reported in Aviation Week & Space Technology p. 50 (9 April 1973).

[3]Kane, op. cit., p. 293.

[4]Furlong, "Space Technology's Gifts to Earth", quoted in Congressional Record, p. E2133 (4 April 1974).

[5]Ibid., p. 2134.

[6]Ted Greenwood, "Reconnaissance, Surveillance and Arms Control", Adelphi Papers, Number Eighty-Eight, p. 10 (The International Institute for Strategic Studies, June 1972).

case of the satellite program is a complex of interdependent security and political considerations in part attributable to the sensitivities of the Soviets and their predilection for antisatellite weaponry. There is, nevertheless, a great deal of information on the satellite program in the open literature, much of it provided by Philip J. Klass. President Johnson provided some measure of the effectiveness of th portion of the U.S. investment in 1967 when he spoke to a group in Nashville, Tennessee:

> I wouldn't want to be quoted on this, but we've spent $35-40 billion on the space program. And if nothing else had come out of it except the knowledge we've gained from space photography, it would be worth ten times what the whole program has cost. Because, tonight, we know how many missiles the enemy has. And, it turns out, our (previous) guesses were way off. We were doing things we didn't need to do. We were building things we didn't need to build. We were harboring fears we didn't need to harbor.[1]

The impact of space technology on national security has been tremendous and will surely continue. The potential for arms limitations would be sharply curtailed if it were not for the nonintrusive verification capability provided by the reconnaissance satellite. Quantitative verification of the existence of strategic systems is fairly reliable today. New weapons must be tested. If the missile enters the atmosphere it can be tracked by reconnaissance satellites augmented by ship and land based radar. Telemetric signals are intercepted by sigint satellites. Firings off a launching pad can be detected by early warning satellites. There is, of course, a limit to the capability of verifying qualitative improvements in adversary missiles. No satellite can yet count the MIRVs in a nose cone nor should we anticipate such a capability. There is great military potential in the space program which will be shaped by multilateral and bilateral treaties, the initiatives of the USSR, and advancing technology. Each of these considerations is discussed below.

In 1971 there were some 250 agreements with 74 countries on the subject

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of space.[1] There have also been agreements reached under the auspices of the United Nations. For example, in the spring of 1962 the United States and USSR agreed to report every satellite launch to the U.N., providing the relevant data on its orbit. (They did not agree to announce the function of the satellite.)[2] In 1962, the United Nations created a Committee on Peaceful Uses of Outer Space to serve as a focal point on international agreements for space activities[3] and to establish its jurisdiction in this milieu which has no semblance of law or sovereignty. There are those who argue for the codification of general principles of space law.[4] At least one treaty[5] signed by 92 nations as of 1972, including the United States and the USSR, recognizes international law as applying to free access to outer space and the celestial bodies. While the sources of agreements, opinions and decisions on restraints on operations in outer space and on celestial bodies may be limitless, there are three which are dominant and which will be used as the basis for this analysis. There are also reservations on the interpretation, permanence, and restraining effects of treaties. As indicated in an earlier section of this module, treaties and agreements have not been reliable guides as to how nations view their commitments. Even given what might be described as a maturation of national conscience, and an increased national responsiveness to world opinion, it is difficult to imagine that allegiance to the letter of a treaty contract would take precedence over national survival, national sovereignty, or even national interests. Within the context of these

[1]Richard M. Nixon, U.S. Foreign Policy for the 1970's, Building for Peace, A Report to the Congress, Vol. II, p. 222 (25 February 1971).

[2]Klass, op. cit., p. 110.

[3]Ibid., p. 124.

[4]See, for example, Crane, "Law and Strategy in Space", Orbis, Vol. VI, pp. 281-300 (Summer 1962).

[5]Treaty on Principles Governing the Activities of States in t[illegible] ploration and Use of Outer Space, Including the Moon and Other Celesti[illegible] dies, 1967 (Article 1).

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reservations, the three treaties cited in Table 11 provide the best point of departure for an analysis of the restraints and freedoms which exist for operating in space and on the celestial bodies.

In general terms, the Table 11 matrix reveals that:

- There are prohibitions against the earth orbiting, installing, or stationing of any mass destruction weapons (to include nuclear weapons) in space or on any celestial body.
- There are prohibitions against establishment of military bases, installations and fortifications or the testing of weapons or the conduct of military maneuvers on any celestial bodies to include the moon.
- There are prohibitions against interfering with any national technical verification of compliance with agreements on fixed land based ICBMs.
- There are <u>no</u> prohibitions against the orbiting around earth or stationing on celestial bodies, or in space, weapons which fall short of the definition "mass destruction" or "nuclear."
- There are <u>no</u> prohibitions against reconnaissance satellites.
- There are <u>no</u> prohibitions against the presence of military forces on the moon or on celestial bodies.
- There are <u>no</u> prohibitions against testing nonnuclear weapons in space.
- There are <u>no</u> prohibitions against the establishment of military bases, forces, installations and fortifications in outer space.
- There is freedom to inspect all stations, installations, equipment and space vehicles on the moon or any other celestial body but no such agreement exists to provide freedom to inspect such instruments in space.
- There are <u>no</u> prohibitions against the intercept or destruction of space vehicles with the exception of those which are dedicated to verification of compliance with agreements on fixed land based ICBMs.

The foregoing and the Table 11 information are based on the specifics of the treaties. There are general provisions which some would classify as the spirit and intent of the treaties and which the cynic would term platitudes. These general provisions set a tone of peaceful cooperation and universal jurisdiction, for example:

Table 11

USE OF SPACE FOR MILITARY PURPOSES AND THE RELEVANT, EFFECTIVE SPACE TREATIES

Military Activities	Environment	Legality		Relevant Treaty[2] [5]
		Authorized[1]	Prohibited	
Orbit of nuclear weapons	Around earth		X	Outer Space
Orbit of mass destruction weapons	Around earth		X	Outer Space
Orbit of weapons which are neither mass destruction nor nuclear	Around earth	X		N/A
Orbit of reconnaissance satellites	Around earth	X		N/A
Installation of nuclear weapons	On celestial bodies		X	Outer Space
Installation of mass destruction weapons	On celestial bodies		X	Outer Space
Installation of weapons which are neither mass destruction nor non-nuclear	On celestial bodies	X		N/A
Station nuclear weapons	In outer space		X	Outer Space
Station mass destruction weapons	In outer space		X	Outer Space
Station weapons which are neither nuclear nor mass destruction	In outer space	X		N/A
Establishment of military bases, installations and fortifications	On moon		X	Outer Space
	On celestial bodies		X	Outer Space
Presence of military forces	On moon	X		N/A
	On celestial bodies	X		N/A
Testing of any type weapon	On celestial bodies		X	Outer Space
Testing of any type non-nuclear weapon	In outer space	X		N/A
Military maneuvers	On celestial bodies		X	Outer Space
Establishment of military forces, bases, installations and fortifications	In outer space	X		N/A

Table II (Cont.'d)

Military Activities	Environment	Legality: Authorized[1]	Legality: Prohibited	Relevant Treaty[2] [5]
Freedom to inspect all stations, installations, equipment and space vehicles	On moon	X		Space
	On celestial bodies	X		Outer Space
	In outer space	[3]	[3]	N/A
Interfering with national technical verification of compliance with agreements on fixed land based ICBMs	Unstated		X	Interim Agreement
Interfering with military space vehicles other than those dedicated to verification of compliance with agreements on fixed land based ICBMs	Anywhere	[4]	[4]	N/A
Nuclear explosion	Outer space where radio active debris carried outside territorial limits of state		X	Limited Test Ban
			X	Limited Test Ban

[1] Activities cited as authorized are not specifically cited by treaty as being so but are rationalized so by virtue of not being specifically excluded.

[2] Short titles provided represent the following treaties as indicated:

Outer Space--Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and other Celestial Bodies, 1967.

Interim Agreement--Interim Agreement Between the United States of America and the Union of Soviet Socialist Republics on Certain Measures With Respect to the Limitation of Strategic Offensive Arms, 1972.

Limited Test Ban--Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, 1963.

[3] Not addressed. It would seem that a strong argument could be made that given the principle of national sovereignty and the lack of specific reference to outer space inspection there is no freedom to inspect such facilities in outer space.

[4] Not addressed. Other than in international law there seem to be no restraints against interfering with military space vehicles and, as applied to international law, it would be subject to interpretation.

[5] See Appendix 3 for a list of signatories to these Treaties. The Interim Agreement was bilateral between the U.S. and USSR.

> The moon and other celestial bodies shall be used by all states parties to the Treaty exclusively for peaceful purposes.[1]
>
> . . .The exploration and use of outer space should be carried on for the benefit of all peoples irrespective of the degree of their economic or scientific development. . . .[2]
>
> Outer space including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.[3]

These general provisions do project an undeniable tone and sense of peaceful purpose in the exploration and exploitation of space.

However, there is broad latitude of interpretation. The extent to which space may be used for military purposes under the conditions of these instruments is debatable. The following are interpretations of these treaties and are cast in terms of current military possibilities. They are presented to facilitate further discussion of the military potentials and threats in space:

- Military satellites for communications, navigation, air traffic control, early warning, tactical weather, sensor monitoring, mapping, and data relay have all been cited by the President's Scientific Advisory Committee[4] as possible space programs. None of these applications appear to be inhibited by current treaties.
- The Soviet's Fractional Orbital Bombardment System (FOBs), an antecedent to the hypothetical Multiple Orbital System (MOBs) which was tested in the late 1960's[5] and which was speculated to be designed to carry nuclear weapon(s), if deployed, would be in violation of the Outer Space Treaty. Specifically, if nuclear armed FOBs or MOBs would violate the restrictions

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[1]United States Arms Control and Disarmament Agency, Arms Control and Disarmament Agreements, 1959-1972, p. 26 (1 June 1972).

[2]Ibid., p. 24.

[3]Ibid., p. 25.

[4]"The Next Decade in Space" Report of the Space Science and Technology Panel of the President's Science Advisory Committee (Washington: GPO, March 1970), pp. 17-18, as quoted in Kane, op. cit., p. 913.

[5]Sheldon II, "The Soviet Space Program," TRW SPACE LOG, Winter 1968-1969 (Redondo Beach, Calif., TRW Systems Group), pp. 17-18 as cited in Kane, op. cit., p. 924.

against the orbiting of mass destruction or nuclear weapons around earth.

- Generally, anti-satellite systems do not appear to be banned by any treaty providing:
  - They are nonnuclear and not capable of mass destruction, and
  - If U.S. or USSR systems, they are not targeted against verification satellites.

The careful integration of all facets of Soviet strategy, economic, military, technological, political and psychological makes it impossible to isolate pure military objectives. There have been speculations and appraisals of the overall programs in open literature including a 1969 writing by Mose L. Harvey from which the following has been extracted:

> In more tangible terms, the Soviet space program has become the key to the long-standing Soviet design to tilt the technological balance of power in the USSR's favor.[1]

In terms of military objectives the same author, in the same timeframe, made this analysis and prediction:

> Nevertheless, the Soviet leadership is highly alert to the military possibilities of space. Like the United States, it has been quick to utilize space research and development to support the missions and improve the capabilities of its earth-based military establishment. Beyond this, the leadership will unquestionably try to derive military advantage in space, if and as this is feasible and promises to result in a net benefit to the USSR. As of now, the Soviets are probably as uncertain as we about whether space can be made to serve military ends in an important way. But it cannot to assumed that they have ruled out the possibility, or that they are not actively exploring what can in fact be done, or that they will not move quickly to capitalize on any opportunity that may open up.[2]

There are differing opinions on the status of the Soviet space program. In March of 1974, Dr. Malcolm Currie, DDR&E, in a pessimistic analysis,

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[1]M. L. Harvey, "Preeminence in Space: Still a Critical National Issue," Orbis, p. 967 (Winter 1969).

[2]Ibid., pp. 968-969.

reported[1] to the Senate Aeronautical and Space Sciences Committee that Soviet expenditures in space may be more than half again those made by the United States. Dr. Currie further reported that Russian space launches from 1947 to the end of 1973 outnumbered those of the United States 708 to 599. During 1973 the Soviets made 87 launches to 23 for the United States. While Currie emphasized that the Soviets were more active and better funded, he did acknowledge that they have "not to date achieved equality in deployed technology with the U.S. in the overall domain of aerospace technology."[2]

In subsequent testimony before the Senate Committee when asked by Senator Moss ". . .is it fair to say that the Soviet space program has been a failure in many respects, far less productive than ours, though far more expensive?" Currie responded, "I would consider it so in some areas, yes, sir."[3]

Aviation Week and Space Technology have minimized the Soviet accomplishments in the space program and emphasized the technical superiority of the United States in this field. In a May 1973 editorial the magazine presented this critical view:

> The Soviet manned space flight program has been floundering in a morass of futility for the past six years, raising serious doubts about its ability to remain technically competitive in the second decade of manned space exploration.[4]

Both positions seem to be correct. First, the Soviets are probably outspending the United States on space programs. Second, the Soviets are, relative to the United States, space technology primitives. The lack of sophisticated space technology base in the Soviet Union has prompted them to seek Western space technology from a number of sources including West Germany, France, England, and the United States. Whatever the cost, whatever the problem, it appears that the Soviet Union is determined to continue

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[1] "Soviet Space Program Prompts Defense Department Concern," Aerospace Daily, p. 28 (27 March 1974).

[2] Ibid.

[3] Aerospace Daily, p. 21 (3 May 1974).

[4] Aviation Week & Space Technology, p. 9 (7 May 1973).

emphasizing their space programs, borrowing or buying as much Western technology as possible. Soviet aims appear to be focused as much upon the psychological as the technical facets of the space program and they are not prepared to concede U.S. preeminance in space.

By 1985 there should be many breakthroughs in space technology. Perhaps solar electric propulsion will be available in lieu of chemical rockets to permit long, fuel-free exploration of space. Perhaps a lunar base will be planned and authorized for a myriad of scientific and exploratory purposes. The ability to capture radiation from the sun for conversion to economical fuels on earth on an experimental scale is a realistic expectation. The USAF's manned orbital laboratory (MOL) may be approved. However, the most significant military developments between now and 1995 appear to be in the applications to be derived from a number of existing and drawing-board earth satellites. The Adelphi Paper titled "Reconnaissance, Surveillance and Arms Control"[1] categorizes sensor satellites as visible light, infra red radar, x-ray and gamma ray sensors. In addition to the sensor or observation satellites we should also recognize the potentials of the antisatellite, or "killer" satellite, and data relay satellites both of which are well within the capability of foreseeable technology.

Observation satellites have both strategic and tactical application. Currently, the most significant strategic application is in the verification of arms control agreements. These verification systems, which have been functioning since 1962, have provided the United States with precise intelligence on the deployment of Soviet missiles.[2] In the visible light spectrum such satellites provide high resolution photography. The infra red applications provide observation in periods of reduced visibility and through camouflage. X-ray applications are useful for detecting nuclear explosions in space while radar satellites provide an all weather capability. The strategic applications of observation satellites are not restricted to arms

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[1]T. Greenwood, "Reconnaissance Surveillance and Arms Control," Adelphi Paper Number Eighty-Eight, (International Institute for Strategic Studies).

[2]Ibid.

control verification, however. Charting and monitoring the movement of ships at sea is another application within current capabilities. As the more sophisticated sensors are developed, it should be possible to locate, fix and track submarine traffic with the same degree of competence in which surface shipping is monitored. The significance of being able to positively track missile submarines will require a complete reappraisal of the dynamics of nuclear strategy in terms of weapon survivability vis-a-vis first and second strike capabilities. The missile submarine is now considered relatively invulnerable to positive surveillance.

The Deputy Director of Research and Engineering (for Strategic and Space Systems) within DDR&E, John Walsh, has been quoted as follows: " . . . we are highly confident that there are no useful techniques which can detect submarines while they are on patrol." Mr. Walsh concedes that it is possible to sweep very small areas of the ocean but that current technology and operational techniques are "several orders of magnitude too inefficient" for broad area search and surveillance of submarines.[1] It is doubtful that the successor of Mr. Walsh will be able to make such a statement in 1985 for the probabilities are good that in 10 years space technology will provide at least a good start on a ubiquitous underwater surveillance system. As indicated earlier, observation satellites teamed with high speed (100 knot) ASW surface craft could drive submarines under the polar ice caps which would substantially reduce the scope of their operating areas. Geodetic satellites provide data for strategic targeting. The Vela nuclear detection satellites monitor nuclear explosions, and early warning satellites are designed to detect and calculate the trajectory of hostile missiles for early defensive warning.[2] The USAF MOL would have provided a human extension to satellite sensor systems but was cancelled in 1969. The currently (1974) successful skylab missions undertaken by NASA in a nonmilitary program have provided the basic data and experience to pursue a military MOL at a later date.[3]

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[1] Space Business Daily, p. 8 (7 May 1974).

[2] Ibid., pp. 9-17.

[3] Ibid., p. 9.

The killer, or antisatellite, satellite has application against systems designed to support both strategic and tactical missions. Aviation Week and Space Technology magazine has reported that the Air Force is conducting a study of an unmanned space system which will detect, intercept, interrogate and, if necessary, destroy hostile satellite systems.[1] The same magazine indicated that the impetus behind the U.S. interest in the satellite-intercept concept originated in the USSR's seemingly successful use of satellites for tactical reconnaissance during the India-Pakistan war of 1972.[2] In the same year the Soviets initiated action in the U.N. to seek the right to destroy alien satellites if an offended nation judged that transmissions emanating from the satellite (e.g., television transmissions) were illegal or erroneous. Gromyko's draft treaty specified illegal areas as those which would be considered:

- Detrimental to maintenance of international peace and security.
- Interference in intrastate conflicts.
- Encroachment on fundamental human rights.
- Violent, horror-oriented, pornographic and drug propaganda.
- Against the foundations of local civilization, culture, mores or tradition.
- Misinformation.[3]

The Soviet initiative is particularly interesting in that it implies that they currently have an antisatellite capability. The implication is reinforced by credible observers who report that the Soviets have developed such a system.[4] Antisatellite systems are not and do not necessarily have to be satellite configured; however, there are certain advantages in such a mode. Air Force Secretary John L. McLucas has testified before Congress[5]

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[1] Aviation Week and Space Technology, p. 11, 5 June 1972, and p. 27, 1 May 1972.

[2] Ibid., p. 13, 19 June 1972.

[3] Ibid., p. 20, 23 October 1972.

[4] Aerospace Daily, p. 62 (10 May 1974).

[5] Ibid.

that the United States has on several occasions seriously considered embarking on a program to develop a space-borne antisatellite system.

Tactical applications of reconnaissance satellites provide great potential for the battlefield commander. As previously noted, the Soviets made full use of such satellites in the 1972 India-Pakistan war. There are also indications that the Soviets launched additional satellites for tactical reconnaissance during the October 1973 war. The Egyptians, on the other hand, complained that the United States had furnished the Israelis with information gleaned from their satellite system. The potential of tactical battlefield satellite systems lies (inter alia) in the following possibilities:

- Deep reconnaissance for theater intelligence and deep interdiction
- Terrain reconnaissance
- Close-in reconnaissance of forces in contact
- Target location and identification
- Battlefield identification of friend and foe
- Poststrike damage assessment
- Friendly damage assessment
- Monitoring friendly lines of communication
- Monitoring helicopter, mechanized, motorized and foot movements
- Reconnoitering contaminated or inaccessible areas.

Given the potential of satellite intercept systems, tactical reconnaissance satellites will have to be capable of providing for their own protection through the use of evasion of neutralization tactics. It would appear that in such a satellite versus satellite or missile versus satellite environment, space reconnaissance systems will require assurances of reliability in the form of redundancy or protective systems.

It appears that introduction of technological innovations into strategic systems is made with relative ease. In structuring and equipping forces at the tactical unit levels, change appears to be made more slowly. The precision guided munitions were in U.S. inventories long before they were effectively employed and proven to be not only highly accurate and lethal but highly cost effective as well. The helicopter was first used in the Korean war for tactical troop movements. The role of the helicopter was

greatly expanded during Army tests in the late 1950s. Nevertheless, the sky cavalry or helicopter-mobile concept was still considered in the mid-1970s to be experimental in terms of force structuring and equipping. It is not the intent to imply that the slower pace of evolution in tactical warfare is wrong or demonstrates inflexibility. Rather, it should be recognized that change does come slowly in the area of tactics and that our expectations for a revolutionary order of tactical warfare in 1985 should be tempered. Space technology may provide periodic, revolutionary change in strategic war potentials, but probably will not for tactical warfare in the timeframe of this paper.

Looking at space as an environment for military operations and space technology potential, the following are considerations for mid-1980 defense guidelines:

- The missile submarine could lose much of its sanctuary to reconnaissance satellites teamed with ASW forces which, in turn, could:
  - create increased interest in ballistic missile defenses due to the degradation of assured second strike capabilities
  - give higher priority to bomber launched missiles, ground launched ballistic missiles and the manned bomber
  - drive the ballistic missile and ASW attack submarine out of open seas under the polar ice cap
  - generate priorities for ASW forces operating in conjunction with ASW reconnaissance satellites
  - stimulate development of remotely controlled, unmanned, ballistic missile submarines capable of extending operating tours at very deep depths.
- Tactical aircraft operating problems could be reduced by virtue of:
  - better environmental data due to satellite reconnaissance
  - reduction in forward base operating requirements with weather reconnaissance and data relay satellites
  - better reconnaissance from fewer reconnaissance aircraft.
- Friendly and enemy air, sea and land lines of communication and support facilities could be subject to completely effective, continuous surveillance, which could require:
  - wide dispersal and concealment of logistic support areas
  - mobile or hardened command sites
  - logistic and personnel strategic transportation systems which do not require large, complex aerial and sea ports

- strategic transport which reduces exposure to interdiction by using cover, deception or speed to compensate for high quality surveillance and intercept.

- A complete reorganization of tactical command, control and communications systems could be required to accommodate the large volume of information produced by space reconnaissance systems and to effectively process and disseminate produced intelligence.

Technology[1]

In this section of Module 1 the period of study is extended from ten to twenty years. In dealing with hardware and operational technology the period of ten years is too brief to make a meaningful forecast. The case of communication hardware developed for the TRI TAC family of systems is a good example of the sterility of ten-year technological forecasts. TRI TAC equipment is being purchased today, on 1974, based on contracts and decisions made over the last several years. The last of the equipment to be purchased will probably be delivered as late as the early 1980s. The equipment has a ten year life cycle. There is little that can be said about tactical communications in 1985 that is not known in detail in 1974. The 1985 tactical communication system was and is being designed and purchased today. However, by looking forward twenty years, we set the stage for the decisions, development and purchases for the next decade up to 1985.

The impact of technology upon the foundation of human society is described by Harold and Margaret Sprout as follows:

> . . .the advance of science-based technology has changed our world more within the past two or three generations than the preceding folklore technology had changed it in 2,000 years or more. Unless this upsurge is terminated by some irreversible catastrophe, technological innovation seems certain to continue transforming our milieu in ways and on a scale only dimly imaginable as yet. Focus on technological advances and innovations directs attention to changes in every other sector of our milieu. For this reason, it provides a productive point, possibly the most productive point of entry, from which to explore the whole range of conditions and trends that are shaping our world.[2]

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[1]For a critique of technological forecasting see Kahn and B. Bruce-Briggs, Things to Come, Thinking about the 70's and 80's, pp. 186-191 (New York: MacMillen Co., 1972).

[2]Sprout, Toward a Politics of the Planet Earth, p. 205 (New York: Van Nostrand Rheinhold Company, 1971).

There seems no doubt that force structure and technology impact one upon the other. Nevertheless, for the purpose of this paper, it appears important that the nature of that relationship be clearly defined. More directly -- does technology drive force structure or does force structure drive technology? Do we or should we structure forces because of technology capacity or should we orient technology to an existing or desired force structure? These are important questions and should be an important concern of R&D policymakers. As the graph in Figure 1 demonstrates, the relationship between technology and force structuring can be plotted as a function of time. In the near timeframe, force structure dominates the relationship. Over this short range, specific military requirements dictate the priorities and task assignments within the technology base. Over the long range, technology tends to dominate and we should visualize or plan for future forces which are compatible to the products of the technology base we have some confidence will eventuate. It does not appear to be a straight-line relationship. In the mid range timeframe, the current or immediately foreseeable force structures tend to dominate the development of the technology base with pure research a lesser priority. In answer to the questions posed above:

- Technology is oriented to current force structure in the near timeframe.
- Force structure planning tends to and should be based on technological potentials in the long range timeframe.

The development of the technology base to respond to requirements of the near timeframe is relatively simple to anticipate. Because we are dealing with a good many knowns, mission-oriented criteria and early, tangible results are feasible. In the long term, the development of the technology base is more complex and difficult to anticipate.[1] All the variables which impinge (i.e., strategy, world order,etc.) are more conjectural. There is also a broader choice within the base in the long range which complicates the assignment of priorities. Or, put in another context, there is far more capability in the base than we could ever economically exploit.

[1]For a description of these difficulties, see Major Joseph P. Martins, "Forecasting the Progress of Technology," Air University Review, pp. 11-20 (March-April 1969).

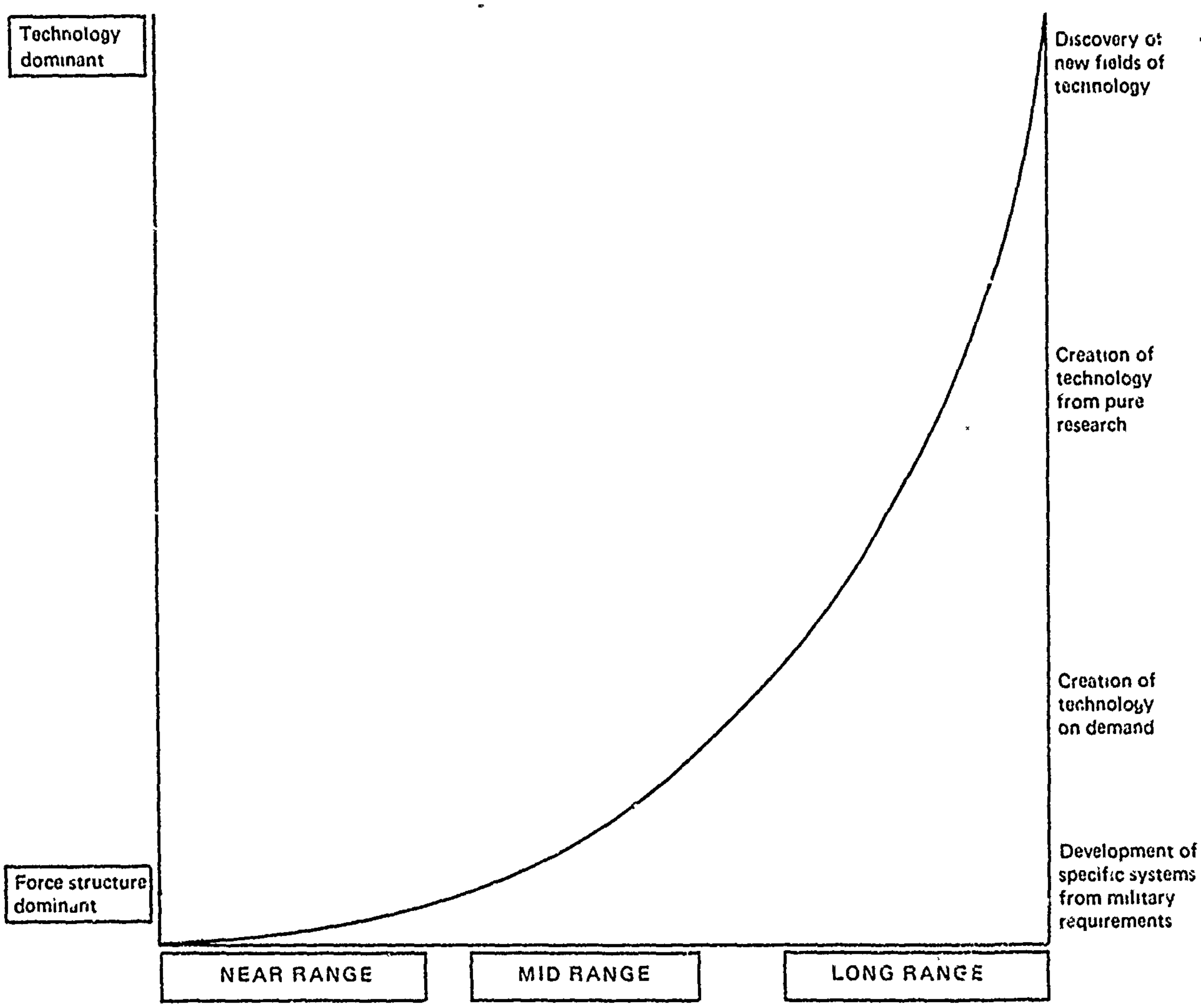

Figure 1 THE ORIENTATION OF TECHNOLOGY OVER TIME [1]

[1] The categories of technology activities displayed on the x-axis or the graph are derived from Stefan T. Possony and J.E. Pournelle, The Strategy of Technology, Winning the Decisive War, (Cambridge, Mass.: sunellen, 1970) p. 63.

The immediate and practical concern in managing the technology base is the determination of priorities for assigning resources to near-term programs (which can be more easily identified within mission-oriented, near-term results) vis-a-vis the resources to be assigned to longer term projects (which could produce a higher return in long-term gain).[1] Decisions made in the assignment of these resources will impact on the design of future force structures and force capabilities which could be stated as follows: the structure and capabilities of future military forces are directly dependent[2] upon the amount of resources devoted to the technology base for long-term programs.

If technology was the only variable in the military force structure equation (which of course it is not) and:

- If there was only a very moderate investment in long-term pure research, then, the force structure of the mid-1990's would be quite predictable. The structure would be responsive to those developments currently on the drawing boards, currently being researched or developed, and
    - U.S. forces would be structured to employ more precise inter-continental missiles each with arrays of reentry vehicles bearing more discriminating and varied yields of warheads with a flexible targetting before and after launch from mobile as well as fixed platforms; silo, air, sea, and rail borne.
    - Few combat aircraft would be piloted and those would include fighter-controller aircraft, airborne command posts and strategic missile platforms.
    - The bulk of naval combatant vessels would be subsurface, nuclear powered, a large number remotely piloted, augmented by an ubiquitous underwater sensor tracking and location system covering all of the most frequently travelled ocean routes. Slightly above the surface shipping would move to a hundred knots or more on air pockets, be primarily auxiliary transport or cargo craft (except for amphibious landing vehicles) and self sufficient in defensive armament.

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[1] Lieutenant Colonel R. D. Hutcheson, "The Dilemma of Air Force Technology," Air University Review, p. 29 (November-December 1970).

[2] The degree of dependence is contingent upon the impact of a number of other impinging variables such as adversary developments, the state of alliances and chance.

- Ground forces would have very sophisticated automated command, control, communication battlefield surveillance and target acquisition systems with highly accurate one-shot, one-kill weapon systems uninfluenced by the vagaries of the environment. Armor will be highly vulnerable, the advantage will accrue to the defense in ground warfare and air defenses will be dominant in areas where a force is itself willing to eschew the use of airspace to permit the designation of free fire zones.
- Laser technology will provide secure, reliable, flexible short range communications, limited tactical weaponry[1] and highly sophisticated target acquisition and weapon guidance systems in both tactical and strategic inventories. Laser-initiated fusion will be a reality.[2]
- Strategic and tactical mobility will increase on the order of three fold in terms of speed for the same lift capacity of 1974. Logistic support will be simplified through highly organized producer-to-user distribution systems, modular replacement maintenance and self-diagnostic equipment. Tactical nuclear weapons will have a wide range of yield, high accuracy delivery systems positioned on very mobile platforms. Sensor and electronic warfare advances will be made which will permit integration of the systems into smaller and smaller units, although at larger and larger costs.[3]
- The overall organization of U.S. military forces will be very similar to those of today except that numbers of personnel in combat and combat service support forces will be proportionately increased.[4]

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[1] M. Mimo III, "The Evolution of Revolutionary Laser Weapons," Air Force Magazine, pp. 54-58 (June 1972).

[2] K. Boyer, "Laser-Initiated Fusion--Key Experiments Looming," Astronautics and Aeronautics, pp. 28-38 (January 1973).

[3] M. Halpern, "Electronic Warfare Technology," Signal, pp. 22-25 (January 1971).

[4] JCS Pub 1, Department of Defense Dictionary of Military and Associated Terms, 3 January 1972, defines these terms as follows:

Combat service support -- (DOD) The assistance provided operating forces primarily in the fields of administrative services, chaplain services, civil affairs, finance, legal service, health services, military police, supply, maintenance, transportation, construction, troop construction, acquisition and disposal of real property, facilities engineering, topographic and geodetic engineering functions, food service, graves registration, laundry, dry cleaning, bath, property disposal and other logistic services.

Combat support troops -- (DOD, IADB) Those units or organizations whose primary mission is to furnish operational assistance for the combat elements.

The ratio of technicians to combatants will increase in favor of technicians and combatants will require higher technical skill levels. The trend will be to either substantially reduce the size of squadron/ battalion units or to allocate resources (e.g., staffs) to subunits (i.e., flights, companies, or sections) to permit a greater degree of self sufficiency for independent operations. A highly structured C^3 system will require force structures which are responsive to direction emanating from more senior levels of command with intermediate levels preoccupied less with operational and more with support activities. Forward deployed force requirements will be met in large part by seabasing.

- If there was a generous investment in long-term, pure research, then the force structure of the mid-1990's would be quite unpredictable. The structure would be responsive to innovations and developments which cannot be foreseen today. However, it is possible that:
  - U.S. forces could be structured to employ strategic weapons which have made nuclear technology obsolete such as charged particle beam weapons, solar earth scorchers, tsunami (tidal wave) generators and shock wave generators. Weapons which have enormous but selective destruction or neutralization potential to immobilize populations without collateral damage would make nuclear weapons crude and relatively expensive alternatives. Laser and infrared anti-missile defenses could make the missile a highly vulnerable and perhaps obsolete weapon carrier.
  - Aircraft could be nuclear powered, hypersonic (Mach 5 and above) wingless vehicles which depend upon the entire airframe for lift. Aircraft could be developed as central command, control and pilot systems to direct multiple remotely piloted vehicles over great ranges, at great speed. Individual slave airborne weapon platforms could be self-sustaining with their own target acquisition, defense and EW capability.
  - Naval forces could be structured to give priority to protecting undersea commercial operations to include deep sea mining, aquaculture and oil extraction. All combatant vessels except the very largest and submarines could be free from the drag effects of surface navigation. Larger craft could be built on the SWATH (small waterplane area twin hulled ship) principle. Durable, high-energy power cells could serve propulsion systems. Floating and underwater naval stations could liberate deployed naval forces from dependence upon foreign bases. The merchant fleet could be largely converted in part to lighter than air vehicles.

- Ground forces could have completely new individual weapon systems which no longer rely on gunpowder for propulsion of metal projectiles. High-capacity, lightweight, backpack energy sources could provide power for laser or laser-like systems which could make the individual soldier a tank-killer, antiaircraft, or antistructure system. Individual mobility or mobility for the very small unit could be increased tremendously. Armor could be obsolete as could be current concepts of air movement in hostile zones under Mach 3 or the massing of infantry in either assault or defense. Conventional artillery systems could be developed to provide longer range, highly accurate nuclear and nonnuclear fire support from very mobile platforms supported by tactical satellite communication systems for fire direction and control. Tactical nuclear weapons could be developed for highly discriminating effect from high-radiation/antipersonnel/low-blast weapons to low-radiation/antipersonnel and structure/high-blast weapons.

- The spin-off from a concerted U.S. R&D effort for energy sources through 1985, plus a generous investment in long-term military research, could generate a good number of substantial breakthroughs in creating, packaging and storing large amounts of energy for discriminating release. Energy cells small enough for the individual soldier to carry and large enough to power aircraft could be developed. A wide spectrum of application from laser weaponry to orbiting atmospheric aircraft becomes possible. The computer, population control techniques and modernized police forces could make insurgency an obsolete form of war.[1]

- The overall organization of U.S. military forces could be very dissimilar to those of today given any one of the conditions postulated. Given several of the developments the <u>Unified Command Plan</u> which assigns area and command responsibilities could require a complete revisions as could the <u>Unified Action Armed Forces</u> publication which sets forth the principles, doctrines and functions governing the activities of the Armed Forces. The reorganization could extend down to the very smallest level of command, the individual ship, plane or small unit which could be required to be immediately responsive to the National Command Authorities.[2] As the capability to destroy or otherwise impact upon an actual or potential adversary increases at the individual or small-unit level, the

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[1] H. Kahn, B. Bruce Briggs, <u>Things to Come, Thinking about the 70's and 80's</u>, pp. 196-197 (New York: The MacMillan Company, 1972).

[2] And even in 1974 there are many precedents for the statement of such a requirement.

requirement for positive command, control and communication at progressively higher levels will likewise increase. One trend of force structure therefore becomes predictable under any circumstance of force improvement - the trend toward better, more reliable, secure, responsive C^3. Given the circumstances described here, the trend toward greater self-sufficiency at the small unit level will be accelerated as will be the trend toward retention of command at higher levels with intermediate commands reduced to emphasis upon managerial and logistic rather than operational functions. Forward deployed forces could be garrisoned at sea on stationary or mobile platforms.

IV SOVIET STRATEGIES

> We Communists have got to string along with the capitalists for a while. We need their agriculture and their technology. But we're going to continue massive military programs, and by the middle eighties we will be in a position to return to a much more aggressive foreign policy designed to gain the upper hand in our relationship with the West.
>
> -Elmo Zumwalt interpreting Leonid Brezhnev[1]

Soviet military strategy, while not immutable, has been fairly consistent. The last major reinterpretation was made in 1960.[2] Soviet strategists are characteristically Clausewitz-oriented and see war as a continuation of policy. War is a political phenomenon and cannot, in the Soviet view, be understood without first understanding the policies from which the war has been derived and the key to understanding lies in Marxist-Leninist doctrine. While the USSR military strategy is based on Marxist-Leninist ideologies, it is not simply an ideological appurtenance but has origins in and derives its sorites from a number of sources which are not always consistent but, as Ken Booth has pointed out, not necessarily incompatible:

> Thus in terms of realpolitik, there is no necessary incompatibility between a set of ultimate aims which may be pragmatic and war-avoiding and a strategic doctrine which has been shaped towards the acquisitive control of territory in the event of war. The interplay between state policy and the international environment inevitably causes multi-faceted postures.[3]

There appear to be four distinct facets of Soviet military strategy which may be identified to provide a taxonomy for this discussion. Two sides of the strategy are defensive and can be labeled deterrence and territorial defense. The opposite sides of the strategy are aggressive and acquisitive and can be

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[1]Admiral Elmo Zumwalt, New Republic, p. 4 (1 June 1974).

[2]H. F. Scott, "Soviet Military Doctrine: Its Continuity - 1960-1970," SSC-TN-8974-28, SRI/Strategic Studies Center (17 June 1971).

[3]K. Booth, "The Military Instrument in Soviet Foreign Policy, 1917-1972," Roman United Services Institute for Defense Studies, p. 58 (September 1973).

labeled political utility and forward projection. The relative importance of these four aspects of Soviet military strategy is indicated in the sequence of priority cited here -- that is, first, deterrence, followed by territorial defense, political utility and, finally, forward projection.

It has only been in the past ten years that the strategic strength of the Soviets has been sufficiently impressive vis-a-vis the United States that they possessed a credible strategic deterrent. Not that the concept of deterrence is a new element in the equation of Soviet military policy, as it dates back to at least the nineteenth century,[1] but the capability to match U.S. nuclear options came only recently. Since parity, strategic deterrence appears to be the cornerstone of Soviet military policy, and the deterrent is convincing. The USSR possesses a substantial strategic strike force which is relatively invulnerable (at least sufficiently so to assure a credible second strike capability) backed by a declaratory policy which enhances the reality of the threat. The Soviet declaratory policy does not as yet acknowledge a predilection or tolerance for a limited strategic nuclear exchange. They offer a view of general war as being a cataclysmic exchange of total force and do not publicly endorse a potential for the limited option policy currently being debated within the United States. Declaratory Soviet policy predictably portrays a strategic exchange as destroying the United States while the USSR survives.[2]

While strategic forces get precedence in the Soviet priority, general purpose forces and a large standing army have historically been most characteristic of Russian force structure. NATO was organized in reaction to the alarming imbalance of general purpose forces between the East and the West in 1947 and what the West perceived to be an expansionist policy of the Soviet Union. Western Europe had good reason to feel threatened. From 1945 to 1948 the Soviet Union extended its control through annexation of close to

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[1] R. L. Garthoff, Soviet Military Policy, New York, Frederick A. Praeger, p. 3 (1966).

[2] B. N. McLennan, M. Earle, Jr., and S. Baum, "War Termination Concepts and Strategic Nuclear Response Options," SSC-TN-8974-78, SRI/Strategic Studies Center, p. 4 (August 1973).

24 million people and 182,000 square miles of 8 East European nations. Other territories controlled by the Soviet Union (Poland, Rumania, Hungary, et al.) included over 95 million people, over 363,000 square miles and 9 separate nations.[1] While NATO has generally viewed the 27 Soviet divisions in Central Europe[2] as a threat to the West, these general purpose forces also have a more proximate utility in maintaining the territorial integrity first of the Soviet Union and, secondly, the area over which the Soviets have extended their influence. As Booth has written:

> . . .the massive and permanent strength of Soviet forces in Eastern Europe was not originally or primarily a function of a Soviet intention to march to the channel, but of the increased military requirements involved in defending Eastern Europe.[3]

The real cohesion of the Warsaw Pact is, as attested to by the Czechoslovak occupation, the Russian general purpose forces. Since the Sino-Soviet rift there has been a second, equally critical requirement to maintain a large general purpose force structure.

Military force represents an important ingredient in the Soviet foreign policy formula. Since the abortive initiative in Cuba they have demonstrated a preference for maximizing military power through the subtle channels of politics and diplomacy rather than confrontation.

> The Soviet Union need have no intention of carrying confrontation to the point of actual military action. In fact, it would be likely that its intention would be to avoid superpower hostilities under all circumstances. But confrontation . . . is a process the length and number of whose stages depend on how cleverly it is directed. The longer a confrontation lasts, the more likely that a democratic political system will

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[1] "NATO, Facts About the North Atlantic Treaty Organization," Paris, NATO Information Service, 1967, p. 7.

[2] The Military Balance 1973-1974, p. 93 (The International Institute for Strategic Studies, London, 1973).

[3] Booth, op. cit., p. 58.

> gravitate toward concessions rather than provoke war against a power perceived as being strategically superior.[1]

A clear Soviet dominance in either strategic or conventional forces could be viewed by Europeans as so threatening that they would be forced to seek an accommodation with the East. Under such circumstances (which has been popularized as "Finlandization"), the Soviets would have maximized political guile through the insinuation of force.

The fourth category of Soviet military strategy, forward projection, has not been as underemployed as a relative U.S.-Soviet historical chronology might indicate. True, the Soviets have avoided a Korea, a Suez, a Taiwan Strait, a Lebanon, a Dominican Republic, a Bay of Pigs, and a Vietnam. They have, nevertheless, suffered a humiliating Cuban experiment and a Hungary and Czechoslovakia. They have had some relative successes in projecting military strength through proxies as in Vietnam and the Middle East. On balance, the Soviets have projected their military power to what must be near the limit of the capability of their armed forces. The October Middle East War seems a classic example of a projection of military power capitalizing on strength and minimizing weakness. During this war, the Soviets advised their Egyptian and Syrian allies well. Soviet military equipment was employed imaginatively and gained at least a temporary military advantage in an arena where the Arab allies had previously only been humiliated. At this writing it is difficult to determine if the Soviets gained or lost leverage in the Middle East through the October 1973 war. They may have been defeated diplomatically in the cease-fire and negotiating stages of the Arab-Israeli conflict. However such should not diminish the significance of their very successful projection of military power through an expansive military assistance program. To date, Soviet successes in projecting military power in the form of troops, air or naval forces outside the Warsaw Pact area have been limited. However, Soviet Defense Minister Andrei Grechko and Navy Minister Admiral Sergei Gorshkov both recognize and have written on the importance of generating a

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[1]W. R. Kintner and R. L. Pfaltzgraff, Jr., Soviet Military Trends: Implications for U.S. Security, p. 10 (Washington, D.C., American Enterprise Institute, 1971).

Soviet capability to project military power outside the reaches of the current Soviet orbit. The Russian construction of an aircraft, the Kiev, and the increased attention which seems to be given to amphibious forces confirm their interests.[1] Soviet strategic airlift is good and the aircraft which ferried emergency supplies and equipment into Egypt and Syria in 1973 could just as easily have carried Soviet troops. Nevertheless, the Soviet capability to deploy forces outside the Warsaw Pact has not been demonstrated and relative to the United States its strategic mobility is primitive. Table 12 provides some comparative U.S.-USSR statistics on strategic mobility during the October 1973 war.

As long as Eastern Europe must be managed through the threat of force, as long as the Soviets can anticipate a U.S. capability to match or thwart a presence in Oman as well as Malaysia, and as long as the Chinese represent a threat on Eastern borders, the USSR will probably not have sufficient force redundance to make force projection a dominant component of military strategy outside the orbit of the Warsaw Pact.

The Soviets view time as an ally in their strategic doctrine. They derive confidence from their ideological convictions of historical determinism which guarantees the ultimate supremacy of Marxist-Leninism as a worldwide social order. While the Soviet doctrinaires view this trend as being inexorable, they assume an obligation to expedite the process through the use of all instruments of national power at their disposal. The Chinese share the confidence of the ultimate supremacy of world communism. The nature of the evolution is, of course, quite different with the Soviets anticipating the revolution of the proletariat while the Chinese anticipate the revolution of the rural peasant. The Chinese operate at the periphery of the globe casting out seeds of dissent and nourishing revolution over great distances. The Soviets are more oriented to their immediate borders and, with the exception of the abortive Cuban experience, extending their influence across relatively contiguous borders. The concepts of time and

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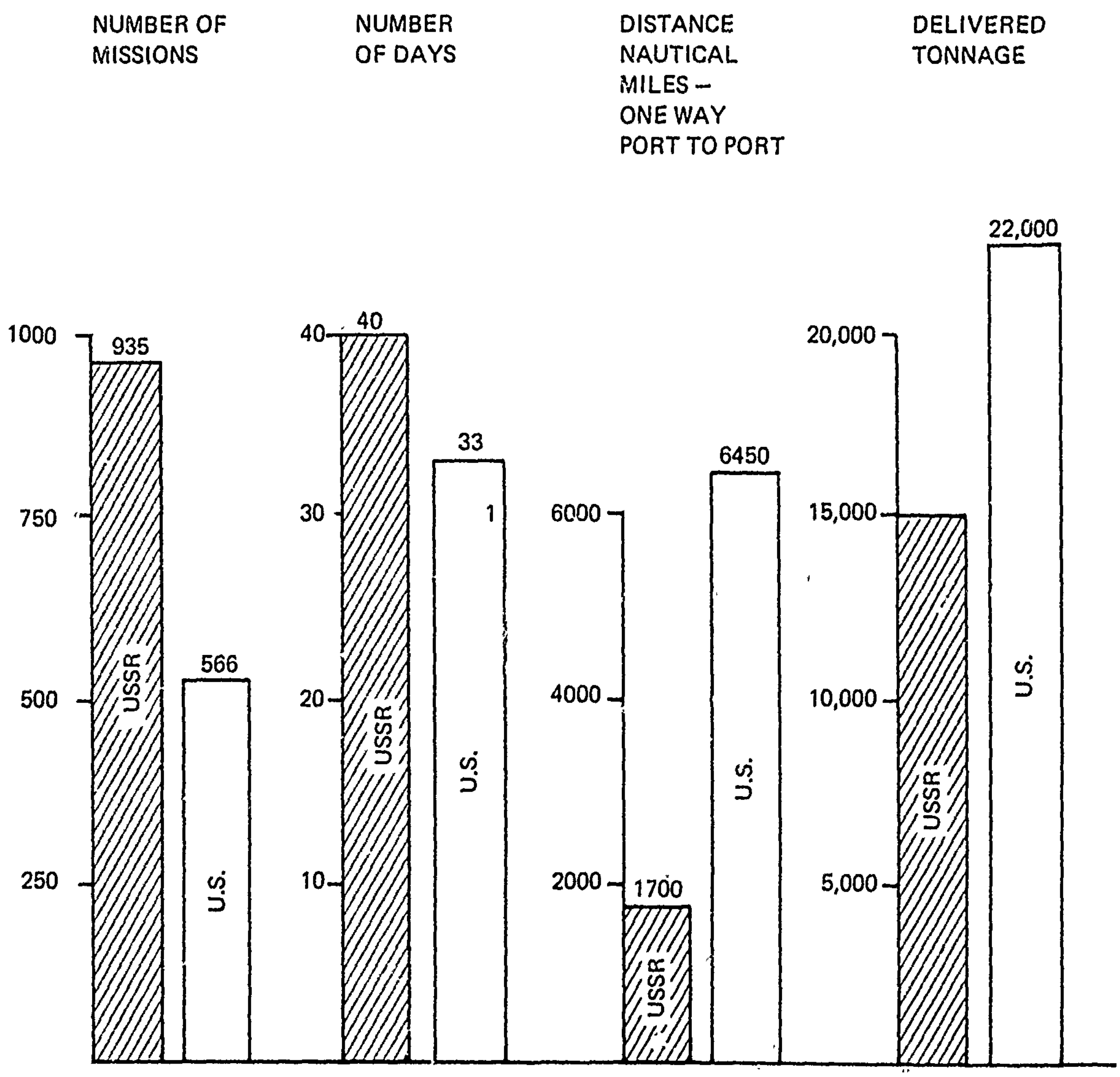
[1]The emphasis Admiral of the Fleet S. G. Gorshkov places on amphibious operations is confirmed in his "Navies in War and in Peace," United States Naval Institute Proceedings, pp. 53-55 (June 1974).

Table 12

OCTOBER WAR 1973 STRATEGIC MOBILITY PERFORMANCE, U.S.–USSR[1]



[1] Statistics reported by Bob Considine, Baltimore News American 14 June 1974, P. 17.

revolution are important components of both strategies, however. The strategy of time becomes more significant when compared to what appear to be U.S. concepts. At the top of the world's economic order, the United States is (in relation to the Soviet Union and the CPR) a counter-revolutionary, status quo power. Time becomes an ally to the United States as each year elapses without a nuclear disaster, without a catastrophic famine, and without international anarchy or world revolution. The differing concepts of time, one fixed on the future and the other on the present, have produced different approaches to long-range strategy giving the ideological initiative to U.S. adversaries. It may be that the principal advantage that the United States acquires in this long-range ideological contest is that Marxist-Leninism will, over time, disprove itself.

What can we expect of Soviet strategy in the next ten years? Generally, more of the same. First priority will continue to be given to strategic deterrence. There are no indicators visible that the Soviets are prepared to join in a communion of strategic intent with the United States and embrace the "controlled conflict" or "flexible option" strategy that has been proposed by Dr. Schlesinger. It seems safe to assume that the Soviets will continue to maintain large general purpose forces to meet the threat they perceive in the East and to continue to dominate Eastern Europe. These forces also serve as a potential threat to NATO Europe and as an instrument of what could become a coercive foreign policy. We should anticipate a continued improvement in the capability of Soviet forces to forward deploy particularly in the areas of naval power and strategic airlift for ground forces.

V DEFENSE PLANNING GUIDELINES

General

In the introduction to Chapter II of this Module it was stated that the trends isolated for examination were not exhaustive, were not exclusive of one another and did not provide a simple formula of discrete variables. By this time the reader has undoubtedly confirmed these vulnerabilities and also identified that in some cases the trends are not compatible and that they can provide conflicting clues to future events. The reader has also undoubtedly discerned that the values of the indicators are unequal. In sorting out the diverse trends and indications, however, there appears to be one, single, overwhelming area of concern which will shape events in the next decade -- economics.

World economics have always been an important component of national strategy and there have been historical precedents when they were dominant[1] just as there are precedents for the dominance of ideology and considerations of territorial acquisitiveness. It seems that today the distinctions are more sharply drawn, however, and that the potential for global crises, turmoil and conflicts is based principally on the distribution of the world's limited resources. The energy crisis, while only the tip of the iceberg, has generated an awareness of a new epoch of world relations. Whatever defense guidelines are approved for the next decade, they each must be weighed against the economic implications for competition for the limited earth resources which will become more and more precious. There will be questions of priorities and the balance of false and genuine economies which will require vision for realistic goals and long-range planning. For example: What economies can be made by concentrating on the construction of conventional rather than nuclear powered ships for the U.S. Navy? What are the long-range costs and implications for refueling conventional ships? Can we rely upon refueling our fleets in foreign ports? What are the economic consequences of a defense

[1] Edward Mead Earle has provided a valuable treatise on the interrelationship of 16th century mercantilism and power politics in his Makers of Modern Strategy, pp. 117-119 (Princeton, Princeton University Press, 1944).

policy which encourages liberally financed military sales to oil-rich Saudi Arabia but not to Venezuela or Indonesia? Is it prudent to seek mutual defense treaties with Jamaica (bauxite), Nigeria (oil), Republic of South Africa (gold)? Are our forward deployments made to facilitate employment in areas where our economic interests are most valuable and most vulnerable?

We hailed the U.S.-Chinese thaw as being a singular event which ushered out an era of bipolarity and introduced a polycentric order to the world. However, the events of 1973 revealed the latent power which resided in the resources of a number of small nations. There is a new perspective of polycentrism. The perspective is one of revolutionary change in international order which reveals the vulnerability of the industrial nations and portends a prolonged struggle for the limited resources of an expanding world.

While we emphasize the importance of economic considerations we do not mean to denigrate other significant factors such as technology, the politics of world order, or geography. Because economic concerns seem to characterize our era they should be highlighted but not at the expense of other strategic issues. Space and the seabed are new dimensions in military strategy. The Soviets' concept of world order and their view of history's inexorable momentum to a Marxist-Leninist state must be an a priori assumption upon which policy is based. The potential for new munitions and new, more effective means of delivering them should not be understated. All of these considerations demonstrate the catholicity and range of view the policymaker must project in the formulation of national strategy.

The defense planning guidelines which follow are cast at a level of concept and detail to serve two purposes. First, they are designed to provide a philosophy of defense and secondly to provide a framework from which force characteristics may be inferred. In this respect, the guidelines are broader and more attuned to the objectives of national policy than are the guidelines found in the annual Defense Policy and Planning Guidance (DPPG).

Planning Guidelines

1. General Guidance and Overall Objectives

Through the foreseeable future, the overall objective of U.S.

security policy will remain defensive, devoted to institutional stability and world social progress as opposed to territorial acquisition, world anarchy and social recidivism. Deterrence of any armed conflict or psychological or political aggression will continue to dominate national strategy. The U.S. declaratory policies and the perception of U.S. total strength are, therefore, equally as significant and effective as operational and effective military strength.

- All national strategic initiatives and declarations must be made with due concern for all the aspects of national strategy, political, psychological, economic, military, technological and social.
- The success of deterrence makes possible the pursuit of a better state of peace and all plans and programs should, as a secondarv concern, promote this objective. The primary concern is deterrence.
- Deterrence is achieved through strength and a successful communication of that strength to allies and potential adversaries.
- Deterrent strength is derived from the sum total of U.S. national institutions as augmented by allies. National strength sources include military forces, economic resources (finance, trade, industrial base, natural resources) geography, population, national character, national morale, science and technology and leadership. The challenge in maintaining deterrent strength is:
  - to promote and maintain national resolve through dynamic leadership
  - to allocate limited U.S. resources to national institutions and allies in such manner that maximum deterrent benefit is derived
  - to limit commitments to achievable and essential objectives
  - to solicit from allies resources essential for defense.
- Effective communication of strength relies upon:
  - a coherent declaratory policy coordinated throughout the national level of government and within defensive alliances
  - the manifestation of the physical attributes of strength through military exercises, demonstrations and deployments.
  - the manifestation of national resolve.
- If deterrence fails, the objective of U.S. security policy must be to deny the adversary advantage at the expense of the U.S. or its allies, to terminate armed hostilities and to insure an outcome which is not unfavorable to the U.S. or to its allies.

2. Priorities

The priority assigned for allocation of resources within the Department of Defense does not necessarily parallel levels of violence but rather, must be based upon the state and nature of the threat, current friendly capabilities and an evaluation of alternative consequences. Over the next decade priority should be assigned to creating and maintaining:

- Sufficient strategic nuclear strength to deter the use of nuclear force against the United States, its forces or allies.
- Sufficient conventional strength in NATO Europe to deter conventional aggression.
- Modestly manned, highly modernized, fully trained general purpose forces with a capability to be deployed or redeployed globally to engage in diverse levels and natures of conflict less than general war.
- An expanding, objective oriented technology base to guard against technological surprise and to provide capabilities for U.S. forces which will maximize relative strengths and compensate for relative weakness.
- Positive strategic control.

3. Nuclear Strategy

A strategy which accommodates flexible options as described in Secretary of Defense Schlesinger's testimony for the FY75 budget will dominate at least the early part of the next decade.

- The national strategic target attack policy must be drafted to direct planning and targeting to support flexible options.
- The national strategic nuclear declaratory policy must provide for the communication of a willingness for the U.S. to accept a policy for controlled conflict. A symmetrical U.S.-USSR relationship of strategies where both sides demonstrate such a commitment is feasible. An asymmetrical strategy where one of the potential adversaries opts only for assured destruction is probably not feasible. The precept implies a communion of intent between adversaries which is adequately communicated and verified by demonstrable initiatives.
- U.S. forces should be structured as a counterforce to adversary forces, not as a mirror image.
- U.S. forces should be structured to provide the highest degree of ready force visibility as an essential element of deterrence and short war fighting capability. Funding for the maintenance of such ready forces may have to be supported from the mobilization base.

- U.S. forces should be structured so as to facilitate ability to absorb technology as easily and quickly as possible.
- Technology should be directed to providing low cost, simple systems, easily employed and easily maintained or which can be economically discarded.
- Forces should be organized to make the most effective use of manpower. The all-volunteer force is currently a political and perhaps a cultural imperative. The concept of a mass army served by conscription is incompatible with current U.S. political and social realities. The all-volunteer force symbolizes the end of an epoch and there are no obvious signs of any possiblity for turning back in this decade.
  - The U.S. must anticipate that NATO allies will move toward similar all-volunteer armies or to a militia system. A strong militia system appears preferable for the defense of Europe.
  - Recruiting, training and retention programs should be given priority call on resources. Recruiting for initial input of qualified personnel, retention to increase professionalism and decrease recruit requirements and training to provide the most effective use of limited forces.
  - Manpower considerations reinforce the necessity to structure and plan for wars of limited duration. Strategic concepts must reinforce the short war philosophy.
  - Reconvene the Key West, Newport, Rhode Island, Conferences of 1948 to reevaluate ways to eliminate wasteful, inefficient and duplicative systems and organizations within the Services.
  - Revise the Unified Command Plan to eliminate and cadre area headquarters.
  - Anticipate that a shrinking manpower base of military age will, by 1990, make retention of current force levels extremely difficult in an all-volunteer force.
  - U.S. assistance programs and equipment should be tailored to the requirements of the allies.
  - Collective security and military assistance programs must be pursued with discretion to insure that U.S. assistance does not promote instability or aggression in an area of vital interest which would be damaging to U.S. interests
- Capitalizing on an appreciation for the strategy of time. National security measures must buy sufficient time to permit an orderly evolution of the world social order to better states of peace and permit adversary ideologies time to accommodate, change or perish.
- Properly rationalizing the dichotomies of the short war--long war, ready force--mobilization base, deterrence--war fighting, mobility--forward deployment, total force--autarkic, high nuclear threshold--low threshold. In rationalizing these dichotomies recognize that they are highly interdependent and that U.S. strategic concepts must remain flexible and not be tyrannized by labels or technical

paradigms. With these reservations emphasis for planning and programming should be based on:

- Wars of limited duration to be fought by ready forces forward deployed where freedom of action and a redploy-ment capability is retained
- The anticipation of a mutually acceptable MFBR which will permit redeployment of U.S. forces from Central Europe, leaving a modest but elite, professional force without degrading the overall defense of NATO Europe.
- A reliance upon allied forces to provide requisite resources for defense
- Increased international violence from para-national organi-zations such as the Palestine Liberation Movement
- A relatively ambiguous declaratory policy on nuclear thresholds which, nevertheless, complements a strategy for wars of limited duration. A relatively unambiguous operational policy for nuclear thresholds based on detailed analysis of consequences at various levels of employment.

• Developing strategic concepts which provide sufficient latitude to capitalize on technology to generate capabilities which maximize force potential on a modest military manpower base.

4. Force Characteristics

The question of how much is enough is answered by: how much do our potential adversaries have, how much will they have, what are their intentions for using their power against us and how resolute are their intentions when faced with a determined defense.

• Symmetrical strategies require relatively symmetrical capa-bilities. This precept introduces the concept of equivalency into the definition of nuclear sufficiency.

• Nuclear strategy must be implemented in such a manner that it:
  - Maximizes the U.S. potential for survival in strategic nuclear war
  - Seeks termination of conflict as early as possible on terms not unfavorable to the U.S. and its allies
  - Promotes and abets the U.S. position in arms control and disarmament negotiations such as SALT
  - Promotes positive strategic control.

5. Other Strategic Concepts

U.S. national strategy must be implemented in such manner that modestly manned general purpose forces retain the capability to meet global commitments at least to the simultaneously prosecuted 1-1/2 war conceptual

requirements. This requirement can be achieved by:

- Increasing the capability to project force into areas of vital interest
  - Deployed forces must be redeployable. They must not be so dedicated to or entrenched in a limited area that redeployment is inhibited. Avenues of egress must not be unduly constrained
  - Forward and intermediary staging and refueling aerial ports must be guaranteed
  - Deployment planning which integrates the efforts of the transportation operating agencies, the Services, the JCS, the unified commander and his subordinates must be standardized
  - Continued emphasis must be given to strategic transport, forward deployed equipment and supplies, reception facilities and intra-theater transport
  - Priorities for defense of sea and air lines of communication must be established for operations during periods of conflict. Defensive planning must include security of terminals such as sea and aerial ports.

- Preparing to defend in new areas of operations to include:
  - Defense of equipment and facilities in space
  - Defense of sea based surface and undersurface commercial and military complexes

- Capitalizing on the strength of allies in collective security arrangements. If an ally's strength lies in manpower, geography, economic wealth or technology, defensive concepts should emphasize these strengths with U.S. and other allies augmenting where required.

APPENDIX B

A DESCRIPTION OF THE FORMAL DOD RDT&E SYSTEM

APPENDIX B

A DESCRIPTION OF THE FORMAL DOD RDT&E SYSTEM

Introduction

This Appendix was prepared to identify the key elements of the RDT&E planning process and to describe the family of plans which are both inputs to and derivatives of the DOD Planning, Programming and Budgeting System (PPBS) process. From these processes and plans stem the actions which also result in the establishment of RDT&E requirements.

This Appendix contains an analysis of the relationship between the Army RDT&E system and the DOD RDT&E planning program and Systems Acquisition process. The Army System was chosen as an expanded example of the RDT&E systems acquisition process; however, the processes of the other Services are similar. The study also includes a description of the AEC and industry interface with the DOD RDT&E System.

The research and analysis of this Appendix was performed by the Martin-Marietta Aerospace Corporation under a subcontract agreement with the Strategic Studies Center of SRI.

ARMY SYSTEM ACQUISITION CYCLE

The Army's System Acquisition Cycle provides a sequential procedure leading from conception to production with verifications of performance and evaluations of progress at several critical points in the cycle. The cycle also provides procedures which permit a weapons system to be developed in a manner that bypasses one or more developmental phases if the need is urgent, or if systems previously developed will fill the need. To attain a complete understanding of the cycle it is desirable to ignore these latter procedural exceptions and discuss in detail each phase in the cycle. (Refer to Figure 1, page 5.)

The birth of a new system comes in the conceptual phase and is a result of the synthesis of the Army using agency (i.e., infantry, armor, artillery, etc.) needs and the Army materiel developing agency (such as the Army Materiel Command (AMC)) scientific and engineering capabilities. The developing agency conducts basic research in all appropriate scientific areas. This research is funded under the 6.1 (Research) funding category and is so numbered to conform with the Department of Defense (DOD) budgeting procedures. When basic research offers high promise of improving a military capability, or if the using agency senses a probable need for which there is currently no technical solution, the using agency and materiel developing agency coordinate in the preparation of a document known as an "Operational Capability Objective" (OCO) which, when approved, directs the research efforts within the Army Materiel Command, or other developing agency, toward solving specific military problems short of major development efforts. Funding of this laboratory effort falls under the 6.2 category (Exploratory Development) and may vary from fundamental applied research to sophisticated prototype hardware, study, programming, and planning efforts.

As the need becomes more urgent or critical and exploratory development increases the promise of scientific achievement, the two agencies join in preparation of a "Required Operational Capability" (ROC) document. The ROC is the heart of the system acquisition process in that it identifies a set of operational goals that meet an established need and in which the goals are believed to be technically

feasible, the probable solutions having been narrowed through scientific investigation. Funding continues under the 6.2 category until the project has moved into developing prototypes for experimental or operational tests. At that time funding is transferred to the "Advanced Development" (AD) (6.3) category.

The Conceptual Phase is considered to be complete when a "Development Plan" (DP) and "Concept Formulation Package" (CFP) have been reviewed and approved. The review and approval may result from a relatively informal In-Process Review (IPR) of "Concept Feasibility" (CF) for minor systems or from formal action by the Army Systems Acquisition Review Council (ASARC) and perhaps the Defense Systems Acquisition Review Council (DSARC) for major systems.

The second phase of the acquisition cycle is called the Validation Phase. By this time a "Program Manager" (PM) normally will have been appointed for a major system. Funding for the Validation Phase continues under the 6.3 (AD) category. Emphasis is placed on development of advanced prototypes and subjecting them to Development and Operational Testing (DT and OT). (For a more complete discussion of DT and OT see Tabs XXI and XXII of Addendum B.) Successful completion of the testing leads to entry into the "Full Scale Development" phase and funding under the "Engineering Development" (6.4) category. Approval to enter this phase is made at the ASARC II and DSARC II level, or at a Validation IPR for minor systems.

Engineering Development concentrates on system development for military use. Prototypes of the militarized systems are tested in DT II and OT II. Satisfactory completion of these tests is reviewed by the ASARC and DSARC at meetings labeled IIA, and "Developmental Acceptance" (DEVA) is granted. With DEVA approval, procurement funds are released and production is initiated. The first production models are subjected to confirmatory tests in a third series of tests labeled DT III and OT III. If necessary to insure timely acquisition, some procurement funds may be expended prior to ASARC IIA/

DSARC IIA. Completion of the tests of production models is reported to ASARC III/ DSARC III for "Produc : Validation" (PV) and the final phase of "Production and Deployment" is entered.

Deployment of a system into army units does not completely end the acquisition cycle. Rarely, if ever, does a deployed system completely satisfy all performance characteristics originally established by the using agency. Moreover, the projected threat continually reflects upgraded capabilities. Hence research and development is charged not only to field new systems, but also to improve the performance of our deployed systems.

In the introduction to the discussion of the acquisition cycle, it was stated that all developments need not go through all phases in the cycle. The Vietnam conflict provided many examples of urgent requirements which were generated by previously unrecognized needs or from the quantities required as a result of rapid buildup. Once acknowledged, many of these requirements were satisfied, at least on an interim basis, by weaponizing an item which had originally been designed for civilian use. Weaponizing generally involves measures to improve the service life of an item, outfitting with communications, or combining it with other items previously accepted for service use. In such instances it is sometimes possible to proceed from the concept formulation phase directly to procurement. It is also possible to initiate a program with a ROC, bypassing the OCO stage. Moreover, the ROC can be prepared and submitted by the using agency, the materiel developing agency, or even by a member of industry. Approval of the ROC, however, normally requires concurrence of both the using and materiel developing agencies.

To further clarify how the funding categories mesh with the Life Cycle Management Model (LCMM) phases and what documentation supports each, Figure 2 displays the relationships. Note that the Army requirement documentation has undergone a series of changes during the past three years from the old "Qualitative Military Requirement" (QMR) concept through the "Materiel Need" (MN) concept to the new ROC.

Figure 3 (page 6) illustrates how the volume of documentation has been reduced by the adoption of the ROC concept.

Figure 4 (page 7) displays the requirements documentation of each department and how it relates to the RDTE categories.

SYSTEM ACQUISITION CYCLE

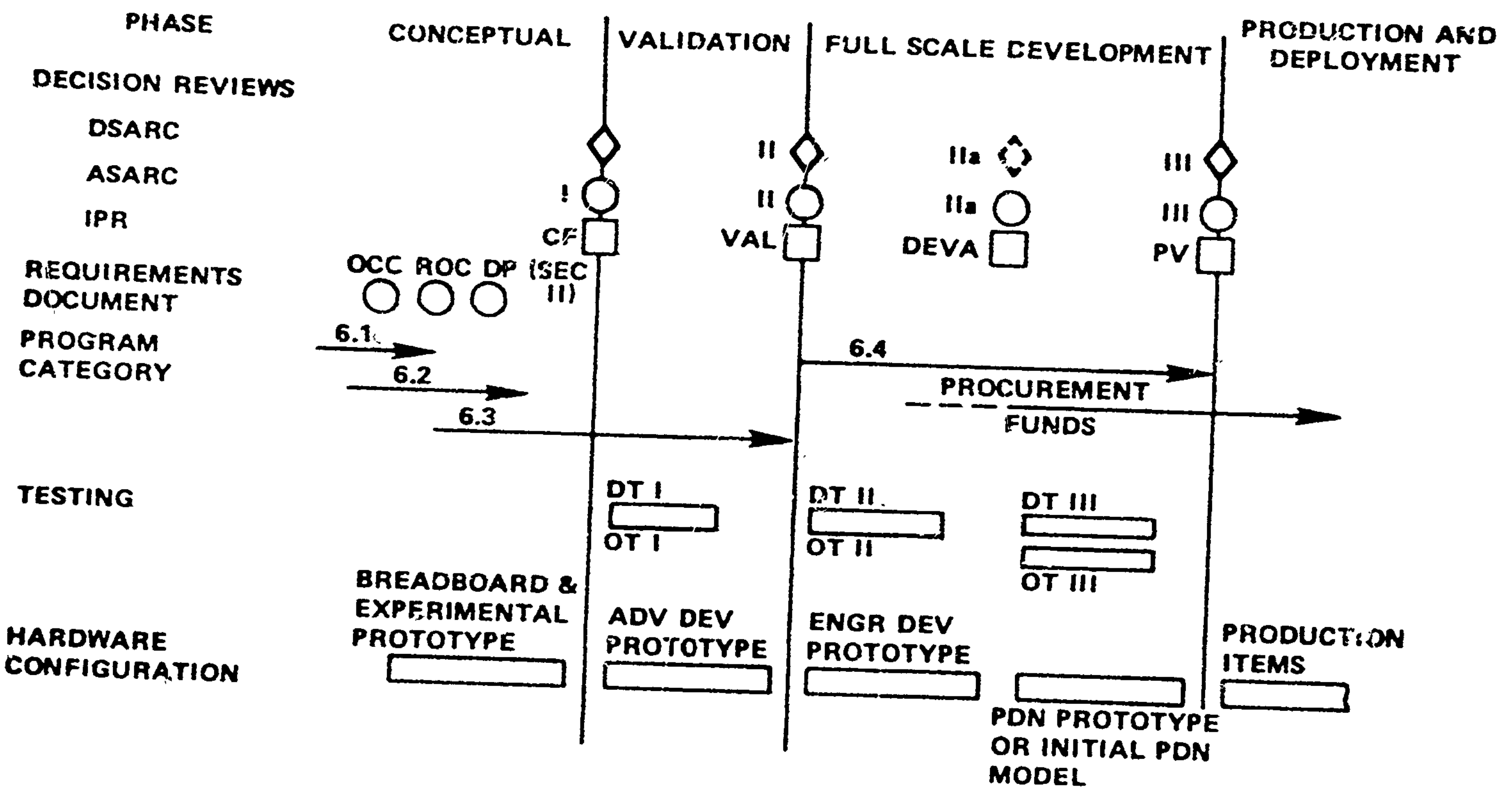


FIGURE 1

RELATIONSHIPS BETWEEN DA REQUIREMENTS, LCMM PHASES, AND RDTE CATEGORIES

RDTE CATEGORY		APPLICABLE DA REQUIREMENT DOCUMENT			LCMM PHASES
		ROC CONCEPT	PREVIOUS (MN) CONCEPT	OLD (QMR) CONCEPT	
6.1	RESEARCH	OCO AND QCR	OCO AND QCR	OCO AND QCR	CONCEPTUAL
6.2	EXPLORATORY DEVELOPMENT	OCO, QRR, QCR, AND ROC	OCO, ARR, QCR, AND MN	OCO, QRR, QCR, AND QMDO	CONCEPTUAL
6.3	ADVANCED DEVELOPMENT	ROC AND DP	MN, MN (ED), AND MN (PI)	ADO, QMDO, QMR AND SDR	CONCEPTUAL AND VALIDATION
6.4	ENGINEERING DEVELOPMENT	ROC AND DP	MN (ED), MN (A) AND MN (PI)	QMR AND SDR	FULL-SCALE DEVELOPMENT
6.7	OPERATIONAL SYSTEMS DEVELOPMENT	ROC AND DP	MN (ED), MN (A), AND MN (PI)	QMR AND SDR	ALL
6.5	MANAGEMENT	N/A	N/A	N/A	ALL

FIGURE 2

RELATIONSHIP OF OLD DOCUMENTS TO DOCUMENTS FOSTERED BY NEW POLICY

OLD	NEW
OPERATIONAL CAPABILITY OBJECTIVE (OCO)	OPERATIONAL CAPABILITY OBJECTIVE (OCO)
INITIAL DRAFT PROPOSED MATERIEL NEED (IDPMN) DRAFT PROPOSED MATERIEL NEED (DPMN) PROPOSED MATERIEL NEED WITH TECHNICAL PLAN (PMN, TP) MATERIEL NEED WITH TECHNICAL PLAN (MN, TP) MATERIEL NEED (PRODUCT IMPROVEMENT) (MN, PI) MATERIEL NEED (ABBREVIATED) (MN(A))	REQUIRED OPERATIONAL CAPABILITY (ROC)
ADVANCED DEVELOPMENT PLAN (ADP) SYSTEM DEVELOPMENT PLAN (SDP) DRAFT PROPOSED MATERIEL NEED (ENGINEERING DEVELOPMENT) (DPMN(ED)) PROPOSED MATERIEL NEED (ENGINEERING DEVELOPMENT) (PMN(ED)) MATERIEL NEED (ENGINEERING DEVELOPMENT) (MN(ED)) MATERIEL NEED (PRODUCT IMPROVEMENT) (MN(PI)) PROJECT MANAGER MASTER PLAN (PMMP)	DEVELOPMENT PLAN (DP)
CONCEPT FORMULATION PACKAGE (CFP) TRADE-OFF DETERMINATION (TOD) TRADE-OFF ANALYSIS (TOA) BEST TECHNICAL APPROACH (BTA) COST AND OPERATIONAL EFFECTIVENESS ANALYSIS (COEA)	CONCEPT FORMULATION PACKAGE (CFP) TRADE-OFF DETERMINATION (TOD) TRADE-OFF ANALYSIS (TOA) BEST TECHNICAL APPROACH (BTA) COST AND OPERATIONAL EFFECTIVENESS ANALYSIS (COEA)
MATERIEL NEED (PRODUCTION) (MN(P))	ELIMINATED

FIGURE 3

RELATIONSHIPS BETWEEN MILITARY DEPARTMENT REQUIREMENTS DOCUMENTS

RDTE CATEGORY	APPLICABLE MILITARY DEPT REQMTS DOCUMENT		
	ARMY	NAVY	AIR FORCE*
6.1 RESEARCH	OCO AND QCR	NRR, GOR, EDR	RO
6.2 EXPLORATORY DEVELOPMENT	OCO, QRR, QCR AND ROC	EDG, TSOR	RTA AND SCO
6.3 ADVANCED DEVELOPMENT	ROC AND DP	ADO AND TDP	ROC AND PMD
6.4 ENGINEERING DEVELOPMENT	ROC AND DP	SOR AND TDP	ROC AND PMD
6.7 OPERATIONAL SYSTEMS DEVELOPMENT	ROC AND DP	SOR AND TDP	ROC AND PMD
6.5 MANAGEMENT AND SUPPORT	N/A	N/A	N/A

*AIR FORCE DATA BASED ON BEST AVAILABLE INFORMATION TO MARTIN MARIETTA. THERE ARE INDICATIONS THAT A RECENT CHANGE MAY HAVE OCCURRED.

FIGURE 4

DEPARTMENT OF DEFENSE (DOD) PLANNING

DOD planning for research, development, test, and evaluation (RDTE) is part of the complex, intricate DOD planning system which is designed to provide a systematic, orderly approach for budgeting DOD needs and for issuing instructions in subordinate elements. This planning for RDTE is a continual process that involves cooperative action at the Office of Secretary of Defense (OSD) level, Joint Chiefs of Staff (JCS) and component service levels. For the following illustration, the Army will be used as the principal component service to describe the planning inter-relationships. (Refer to Figure 5, page 15, for a graphic view of this description.)

Planning proceeds through four phases, the first phase developing an "Appreciation of Force Balance and Trends." The phase is initiated with the preparation of the "Joint Long Range Estimate Intelligence Document" (JLREID) which provides the principal intelligence basis for long range strategic studies and development objectives. The JLREID summarizes factors and trends affecting world power relationships ten to twenty years in the future. The responsible agency for this document, the production schedule, period(s) addressed, number of volumes and titles, and a synopsis of contents may be found in Tab X to Addendum B. Later references to these tables will use the form "See Synopsis, Tab X to Addendum B."

Concurrent with JLREID is the "Joint Intelligence Estimate for Planning" (JIEP) which covers the short and mid-range periods and includes regional intelligence estimates. (See Synopsis, Tab IX to Addendum B.) JLREID and JIEP provide a basis for the Army to develop its basic threat analysis for the short, mid, and long range periods in a document called "Army Analysis of Intelligence" (AAI). (See Synopsis, Tab I to Addendum B.).

JIEP is also used by the Joint Staff in the development of the "Joint Strategic Objectives Plan" (JSOP) (see Synopsis, Tab XIV to Addendum B) which is prepared in two volumes. Volume I provides concepts, tasks, and planning guidance for the services to use in preparation of their own strategic objective plans. More specifically, JSOP I provides guidance on forces, logistics, intelligence, and the development of multilateral and bilateral plans for the service and defense agency staffs. Using JSOP I

and the AAI, the Army staff prepares Volume I of its "Army Strategic Objectives Plan" (ASOP) (see Synopsis, Tab V to Addendum B). ASOP I translates JSOP I guidance into Army terms and provides a basis for Army input into JSOP II. Completion of ASOP I ends the first phase of planning.

The planning in this first phase usually has an indirect relationship with RDTE planning. There may be a direct relationship if intelligence indicates research and development advancements of potential enemies have provided them with advantages in important scientific fields. However, this phase usually outlines an accepted threat and a national strategy to meet that threat. In so doing it outlines requirements which must be satisfied in order to cope with the threat. These requirements include research and development requirements when this appears to offer the greatest potential.

The second planning phase is the "Derivation of Annual Requirements and Objectives." OSD initiates this phase with its review of JSOP I and publication of a "Defense Policy and Planning Guidance Memorandum" (DPPG) (see Synopsis, Tab VI to Addendum B) which contains definitive guidance for the JCS and military services for DOD force planning, including development of JSOP II. It updates and enlarges on JSOP I based on Presidential guidance and changes in the national objectives. It also identifies "Issues for Selected Analysis" necessary for the development of the defense budget. These issues, which may include detailed analyses of proposed RDTE projects, are designed to provide data for important decisions to be used later in the planning sequence.

Using the DPPG guidance, the Joint Staff prepares Volume II of JSOP which recommends objective force levels to the Secretary of Defense, appraises programs, and provides military risk evaluations. Concurrently, the Army Staff develops ASOP II. Information flows continually between the two staffs so that ASOP II can provide the Army recommended force objectives and resource requirements to execute the approved strategy.

During this second phase, the Joint Staff, using background developed in the JLREID, completes the "Joint Long Range Strategic Study" (JLRSS) (see Synopsis, Tab XI to Addendum B), a source document

that addresses the strategic implications of world-wide and national economic, political, social, technical, and military trends along with a consideration of their impact on national objectives, policies, and military constraints. The JLRSS stimulates more sharply focused strategic studies and the technical trends contained in it are the prime source for development of the "Joint Research and Development Objectives Document" (JRDOD) (see Synopsis, Tab XII to Addendum B).

The JRDOD translates the broad strategic implications projected in JLRSS and the objectives of JSOP II into research and development (R&D) objectives. This document is one of the principal documents in which a major effort is made to reconcile differences which may occur between the desires of unified and specified commanders and those of the military services. Requirements and objectives generated by the former commanders enter the system most often through military service channels and frequently have a lesser priority in a particular service than similar requirements and objectives developed within that service. It is in the Joint Staff action that develops this document that those differences are reconciled and overall priorities are established. It may be fairly stated that one of the major duties of the Joint Staff in the research and development field is to insure that national needs are unified and specified commander needs receive their proper consideration.

During this phase the Army also prepares the Army Force Development Plan (AFDP) (see Synopsis, Tab II to Addendum B) which structures in detail the approved force for the year following the budget year, structures in detail the approved force for four additional years, and proposes modernization of the Army for the ten years following the budget year. Research and development objectives of the Army, or of Unified and Specified Commanders which pertain to the Army, are reflected in this plan. The AFDP provides a sound analytical base for Army participation in OSD and Joint planning, programming, and budget cycles.

With this documentation as a base, OSD initiates the third phase, "Programming Priority Objectives" by issuing the "Planning and Programming Guidance Memorandum" (PPGM) (see Synopsis, Tab XVII to Addendum B). The PPGM uses analyses and force tabulations from JSOP II and research and development objectives from JRDOD, and provides guidance to the JCS, other OSD agencies, and the military services on force planning levels, fiscal levels, and materiel support planning.

The guidance contained in the PPGM is translated into constrained force levels, within major mission and support categories, by the Joint Staff in the "Joint Force Memorandum" (JFM) (see Synopsis, Tab VIII to Addendum B). Preparation of the JFM is based on the PPGM with consideration of the DPPG, JSOP, and the prior "Five Year Defense Program" (FYDP). It includes a summary of analyses and assessments of risks associated with the constrained force as measured against the strategy and military objectives, and highlights major force issues which will require decisions during the current year. It should be noted that research and development requirements and objectives previously approved may now be disapproved as a result of the constraints imposed.

The Army Staff, using guidance contained in JSOP as modified by the DPPG and PPGM, expresses total program requirements to include force, manpower, cost and materiel recommendations, along with the risk assessment in a "Program Objective Memorandum" (POM) (see Synopsis, Tab XIX to Addendum B). The Joint and Army staffs provide a cross flow of information on emerging results of the JFM and POM.

The POM also draws heavily on an Army document called the "Army Force Program" (AFP) (see Synopsis, Tab III to Addendum B). The AFP develops in detail the approved Army Force structure, develops force planning guidance (including that for research and dev-lopment) for the Army Staff, and supports the budget request throughout the budget cycle. The AFP is continually updated using information from the AFDP.

With the submission of the JFM and POM to OSD, the necessary background data is compiled for initiation of the "Budgeting, Evaluation, and Decision" phase. This phase starts when OSD publishes the "Program Decision Memorandum" (PDM) (See Synopsis, Tab XVII to Addendum B) which transmits his decisions that are based on the JSOP, the fiscally constrained forces and appraisal of risks in the JFM, the POM's, and the selected analyses. The PDM contains a "Resource Annex" which provides a translation of resources to program elements (including research and development) in the Five Year Defense Program (FYDP) (see Synopsis, Tab VII to Addendum B).

Changes to decisions announced in the PDM and FYDP are announced as they occur in "Program/Budget Decisions" (PBD) and the POM is modified accordingly. The PDM and PDB's are used by OSD to prepare and update the new FYDP and by the Joint and Army Staffs to prepare the "Joint Strategic Capabilities Plan" (JSCP) (see Synopsis, Tab XIII to Addendum B) and the "Army Strategic Capabilities Plan" (ASCP) (see Synopsis, Tab IV to Addendum B), respectively. The FYDP is the official DOD program defining the approved force structure and resources for its support. It supports the defense budget submitted to the President and, in turn, to Congress.

The JSCP provides JCS guidance and missions to commanders of unified and specified commands and to chiefs of the component services. The ASCP is the Army complement to the JSCP providing guidance and missions to Army commands and agencies.

There are certain other documents which become important because of their relationship to nuclear weapons planning or to research and development in particular. The first of these is a portion of a document previously discussed - the Joint Force Memorandum. The "Nuclear Annex" to the JFM (see Synopsis, Tab XV to Addendum B) considers the same items as the parent document and provides the views of the JCS on future nuclear weapon stockpile requirements, consistent with fiscal constraints, and on the position which the Secretary of Defense should take on the Presidential Stockpile Memorandum which the SECDEF and the Chairman, AEC, submit jointly each year to the President for his approval.

The second document which is not a part of the formal planning system is the "Nuclear Weapon Development Guidance" (NWDG) (see Synopsis, Tab XVI to Addendum B). This document is particularly important in conveying the views of the JCS to the SECDEF, and those approved by the SECDEF to the AEC, on qualitative requirements for new nuclear weapons and on technological goals in support of future nuclear weapon developments.

The third of these documents is a class of documents produced by all of the military services to support projects for which developmental funds are requested. This document is known as a "Development Concept Paper" (DCP) (see Synopsis, Tab XX to Addendum B). The DCP outlines all issues and important factors surrounding the development and later acquisition of a weapons system and includes, when appropriate, the necessary interface with the AEC if a new nuclear warhead or bomb must be developed by the AEC for integration with the system.

Figure 5, page 15, also contains the months (in parentheses) which are the normal target period for the production of that particular document or documents. If, for example, the planning sequence is directed to the decisions which must be made for the funds to become available on 1 July 1975, JSOP, Volume I, which provides advice to the President and SECDEF on military strategy and force strength requirements for attaining the national security at that time, would be produced by May 1974, and would be one of the bases for the remainder of the sequence.

Figure 5 may be usefully compared with Figure 6, page 15, which depicts the Joint and Army Planning Sequence and includes those plans and documents which are produced by those agencies. Shown are the applicable calendar years, fiscal years, and months at the top of the figure, and the various closely related plans and documents down the side. Each bar lists the general period of preparation and utility of each plan or document, and the time period to which each is addressed. The key month(s) as shown in Figure 6 falls somewhere within each applicable bar. The set of plans and documents is designed by cross-feeding to develop a composite whole which outlines the importance and funding support of personnel, operations, logistics, construction, and modernization for future years.

A system is thus represented which assures the exposure of all conflicting issues for decision to include priorities between competing weapons systems for research and development funding and the systems force goals for later acquisition.

INTER-RELATIONSHIPS OF DOD, JOINT AND ARMY PLANS

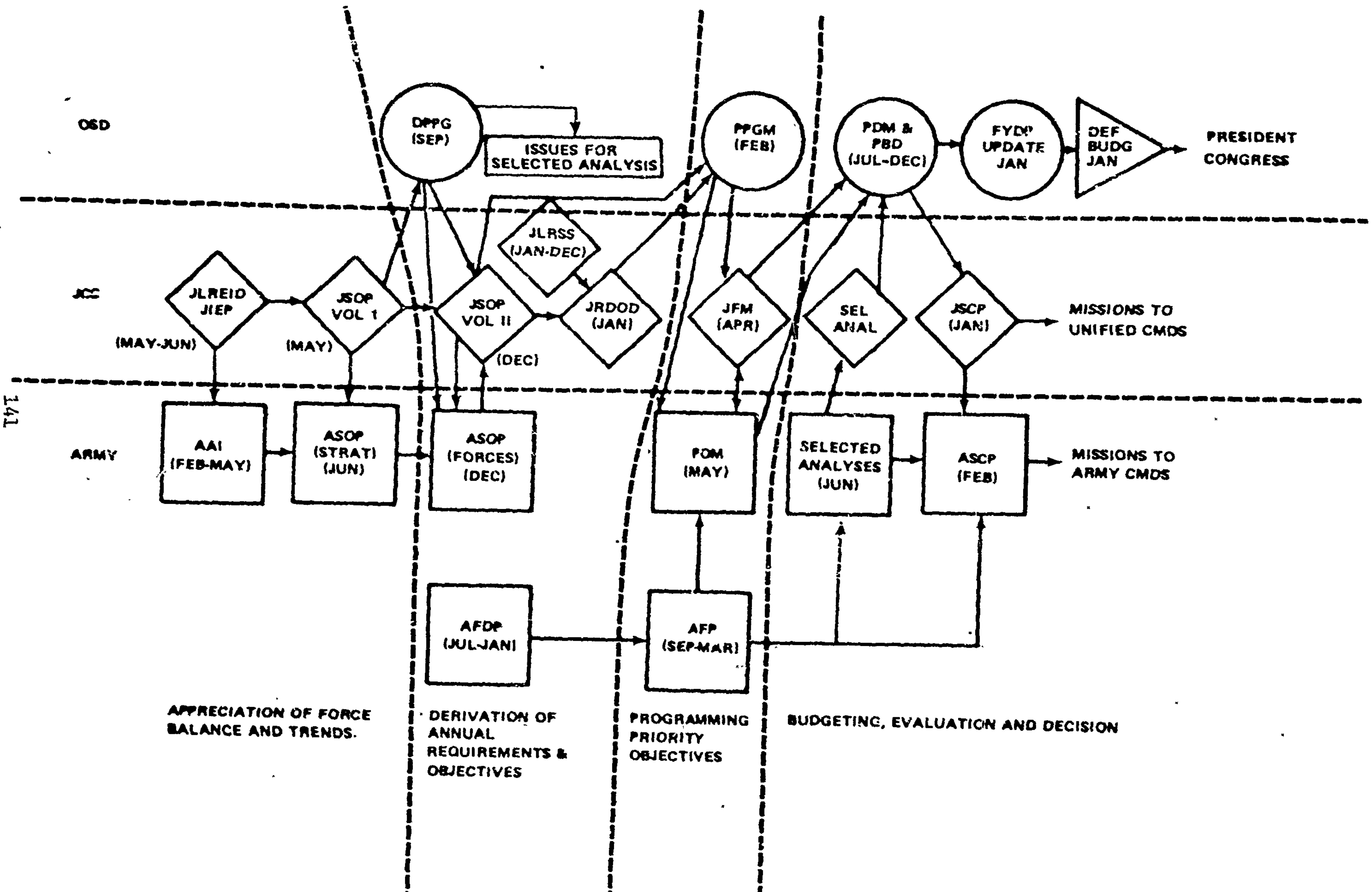


FIGURE 5

JCINT AND ARMY PLANNING SEQUENCE

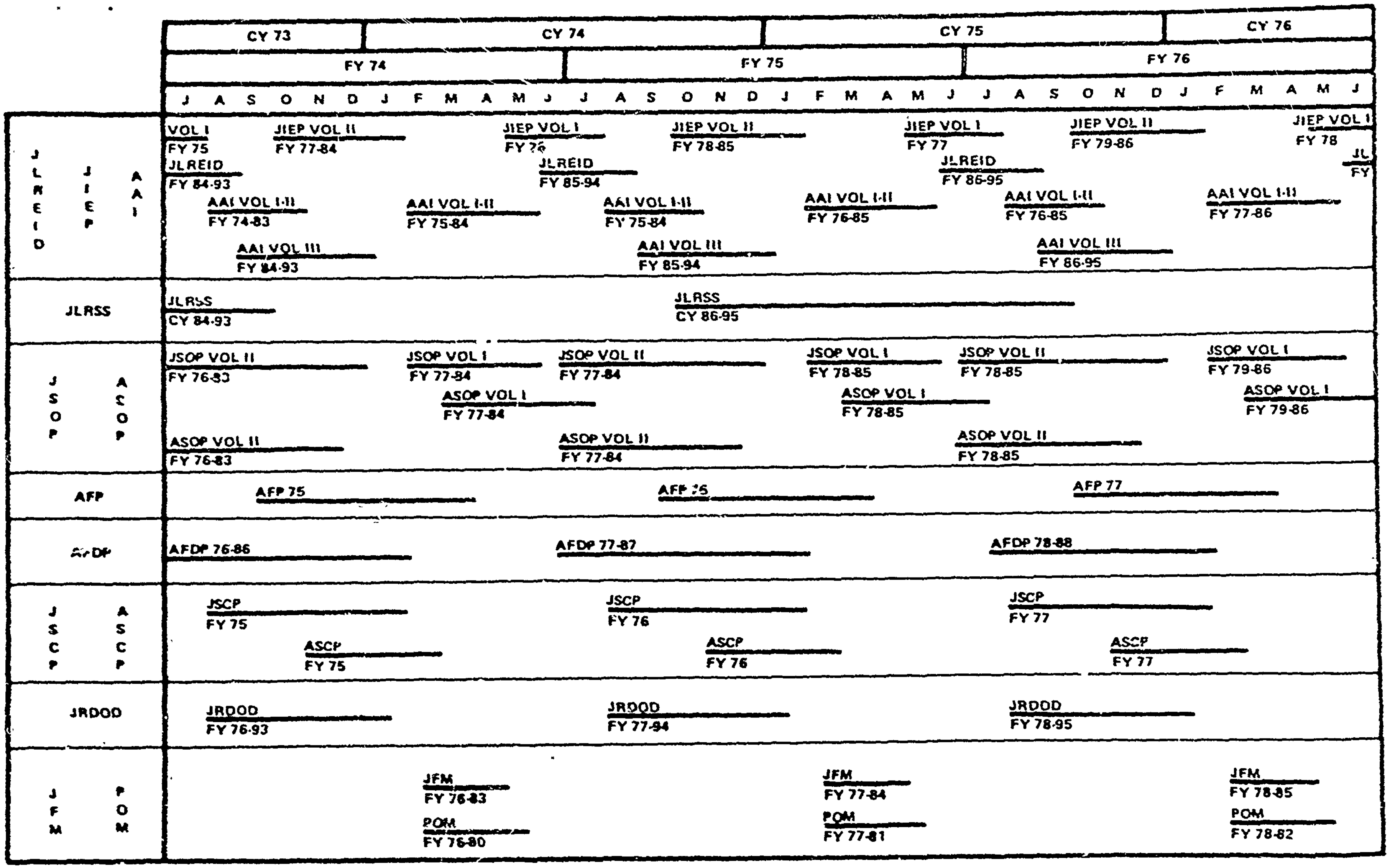


FIGURE 6

A DESCRIPTION OF THE FORMAL
ATOMIC ENERGY COMMISSION SYSTEM (AEC)

AEC - Nuclear Weapon Development

Phase 1 - Weapon Conception

The development of nuclear weapons is a coordinated effort between the AEC and DOD that moves through five development stages leading to the sixth, final stage of production.

Phase 1 (see Figure 7, page 19) consists of weapon conception and is essentially a period of basic research wherein the military departments and the AEC laboratories exchange information. The product of Phase 1 is the focusing of sufficient data in the proposal for a new weapon to warrant a program study. This takes the form of a draft Phase 2 request.

The process may be considered to start when the DOD, usually through the mechanism of the "Nuclear Weapon Development Guidance" (see Synopsis, Tab XVI to Addendum B) prepared by the JCS and as modified by DDRE, provides annual development guidance through the Military Liaison Committee (MLC) to the AEC.

The MLC is the single channel through which official communications may pass between the DOD and the AEC. The establishment of the MLC predates the establishment of the Organization of the Joint Chiefs of Staff; and as a result, it consists of the Assistant to the Secretary of Defense (Atomic Energy) as Chairman with members from the Departments of the Army, Navy, and Air Force. This arrangement is in the law, and because a member of the Joint Staff always sits as an observer, it has not been necessary to seek a formal change to the law.

The task of disseminating the guidance throughout the AEC is a responsibility of the Division of Military Application (DMA) which is headed by a military officer from DOD. AEC subordinate agencies study the guidance, compare it with past development tasks, and make estimates based on their latest scientific investigations to determine which AEC accomplishments and capabilities might be applied to satisfy the requirements and objectives in the guidance. The findings take the form of an Annual Weapon Development status report, which when sent to DMA, is forwarded to the DOD for dissemination to the Director of Defense Research and Engineering (DDRE), to the MLC, and to the military departments. If in a given case a military department then decides that a particular weapon system embodying a nuclear warhead or bomb is needed to satisfy future requirements, it would forward a conceptual study of the

entire system and a draft Phase 2 request for the nuclear warhead or bomb to the DDRE. DDRE forwards this to the MLC to be placed in final form when a decision is made to ascertain the feasibility of the entire system.

The consideration of the final form of the Phase 2 request is a voting item within the MLC because the weapon system desired by one military department may impact unfavorably on the weapon systems proposed or to be proposed by another department. In extreme cases, the separate advice of the Joint Chiefs of Staff as a corporate body might be sought before proceeding.

PHASE 1 — WEAPON CONCEPTION

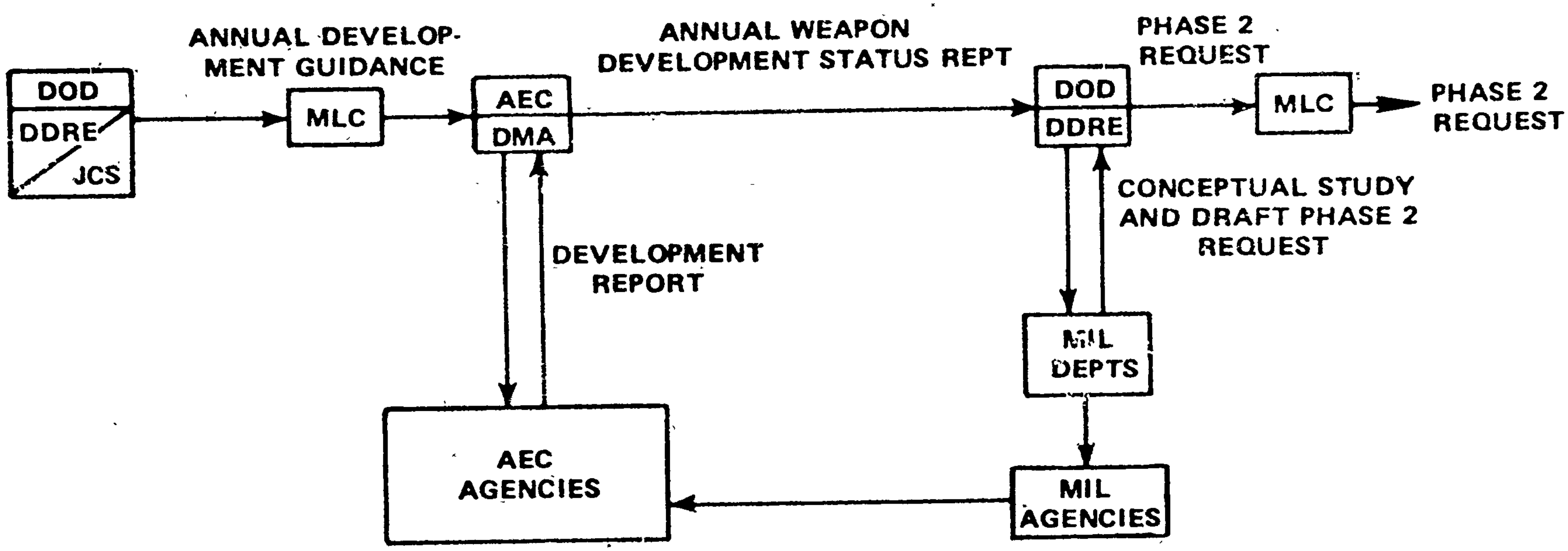


FIGURE 7

AEC - Nuclear Weapon Development

Phase 2 - Program Study

Phase 2 (Figure 8) starts with the forwarding of the study requirement by the DMA to the appropriate AEC agencies. The interested military service(s) participates as required under the chairmanship of the Field Command, Defense Nuclear Agency (FC DNA).

The study seeks to determine the feasibility and desirability of undertaking the development of a new weapon or component, to establish the military characteristics, and to determine AEC and DOD responsibilities for tasks involved in development and procurement. The data gathered by the study group which produces the feasibility study include the nuclear weapon feasibility examinations supplied by the AEC agencies, pertinent data on the remainder of the system supplied by a designated agency of the most concerned military service, and military characteristics developed by FC DNA after detailed consideration of the stockpile-to-target sequence supplied to it by the military service agency.

Study results are forwarded directly to the interested military service(s). Upon consideration of study results, the sponsoring military service(s) may forward to the JCS and DDRE a development request for both the complete system and the nuclear warhead or bomb. Upon DOD approval, the nuclear weapon development request is forwarded to the MLC where it is joined by the military characteristics which have been forwarded by the FC DNA through DNA to the MLC. When the MLC forwards this consolidated request to the AEC, FC DNA will supply the stockpile-to-target sequence to interested AEC agencies.

PHASE 2 – PROGRAM STUDY

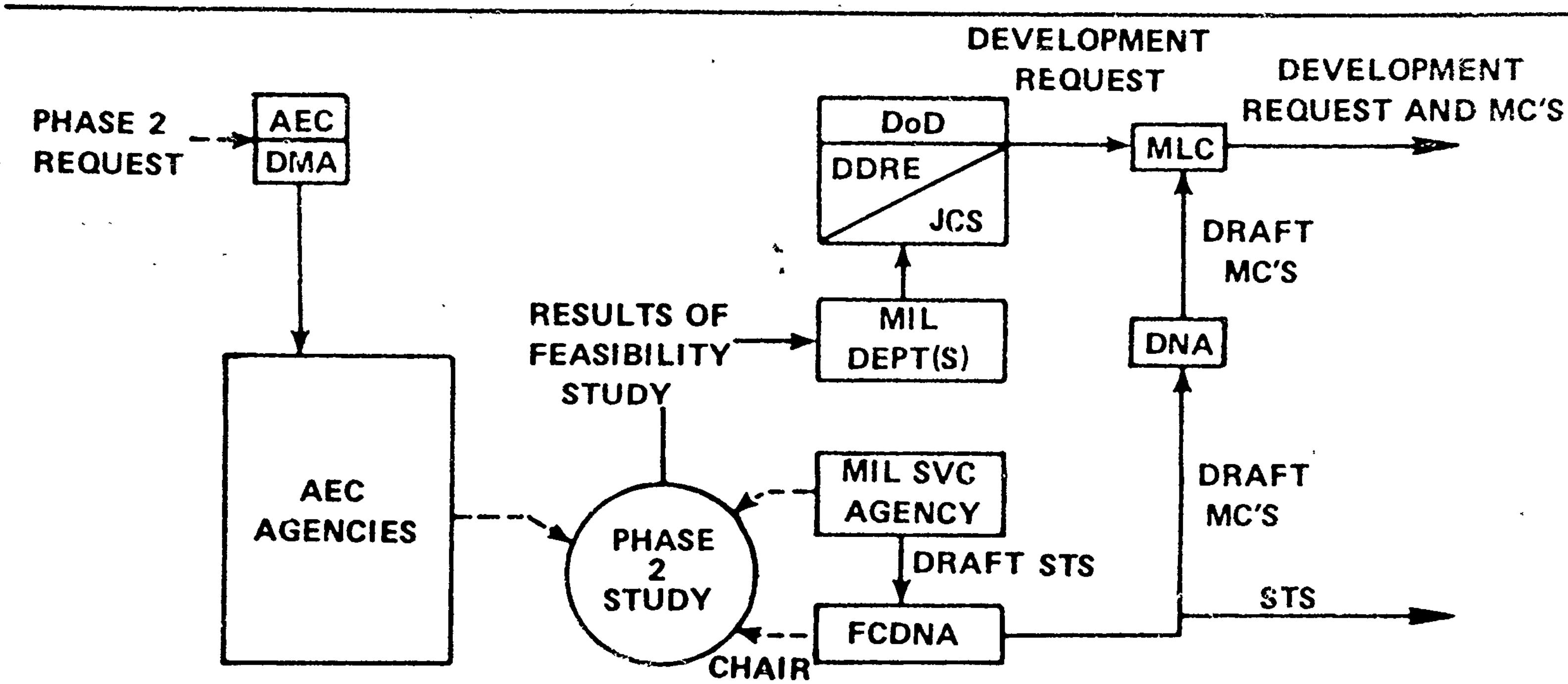


FIGURE 8

AEC - Nuclear Weapon Development
Phase 3 - Development Engineering

On receipt of the development request and military characteristics, a Development Directive is issued to one or more of the AEC agencies. This directive initiates Phase 3 (Figure 9). Liaison through a project officer is established between the AEC agency(ies) and the military service(s), contractor, and FC DNA. The weapon is designed to military characteristics and the design released to production facilities.

As development proceeds, the Joint Chiefs of Staff each year determine quantitative stockpile requirements in the Nuclear Annex to the JFM (see Synopsis, Tab XV to Addendum B) which have been processed by the Director of Defense Program Analysis and Evaluation to become a part of the joint annual memorandum from the SECDEF and the Chairman, AEC, to the President for his approval. The sponsoring service insures the timely inclusion of quantitative requirements for systems in development consistent with completion of the development and the production capability of the AEC.

The final result of this process is a production directive. These requirements, along with the non-war reserve requirements, are forwarded through the FC DNA and the Albuquerque Operations Office (ALOO) of the AEC to the production facilities in the form of a Preliminary Planning Schedule for production quantities. When a determination can be made of a date to commit to DOD for the First Production Unit, War Reserve (FPU/WR), ALOO issues an Authorization Planning Schedule.

PHASE 3 — DEVELOPMENT ENGINEERING

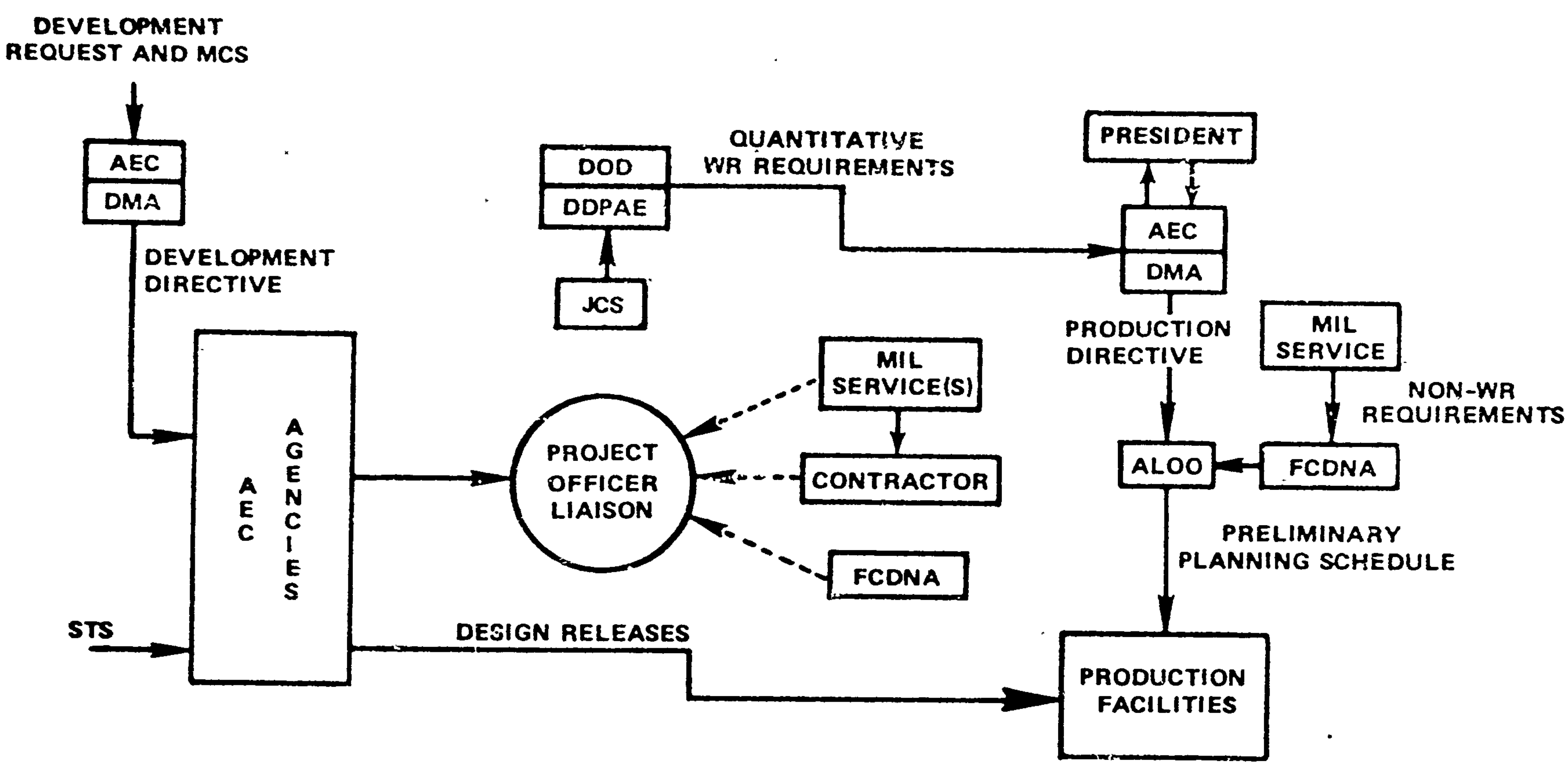


FIGURE 9

AEC - Nuclear Weapon Development

Phase 4 - Production Engineering

The Authorization Planning Schedule initiates Phase 4 (Figure 10) development which is similar to the production engineering of any system, in that it involves the translation to production tooling. It also includes achievement of the Nuclear Weapon Complete Engineering Release (CER). Phase 4 concludes with the approval by the AEC Design Agencies of the pilot production and tool-made samples.

Phase 5 - First Production

The appropriate AEC Agency next releases the Directive Schedule to initiate production. After first production units for operational suitability tests are produced and tested by the AEC Design Agencies, three actions are taken by these agencies. Technical feedback is provided to the production facilities with the view of improving quality in future weapon production, major assembly releases are made to initiate quantity production, and a Final Development Report is forwarded to FC DNA which is charged with processing the report to obtain standardization and acceptance by the Department of Defense. FC DNA is assisted in this task through the efforts of the Design Review and Acceptance Group (DRAAG) which is chaired by the FC DNA representative but contains members from the Army Materiel Command Field Office, the Navy Materiel Command, and the Air Force Weapons Laboratory. This group provides a report (termed the DRAAG Report) and a Draft Proposed Standardization Statement which is forwarded through DNA to the MLC. Upon DOD approval, the final standardization is provided by the DOD through the MLC to the AEC and initiates Phase 6 - Quantity Production and Stockpile.

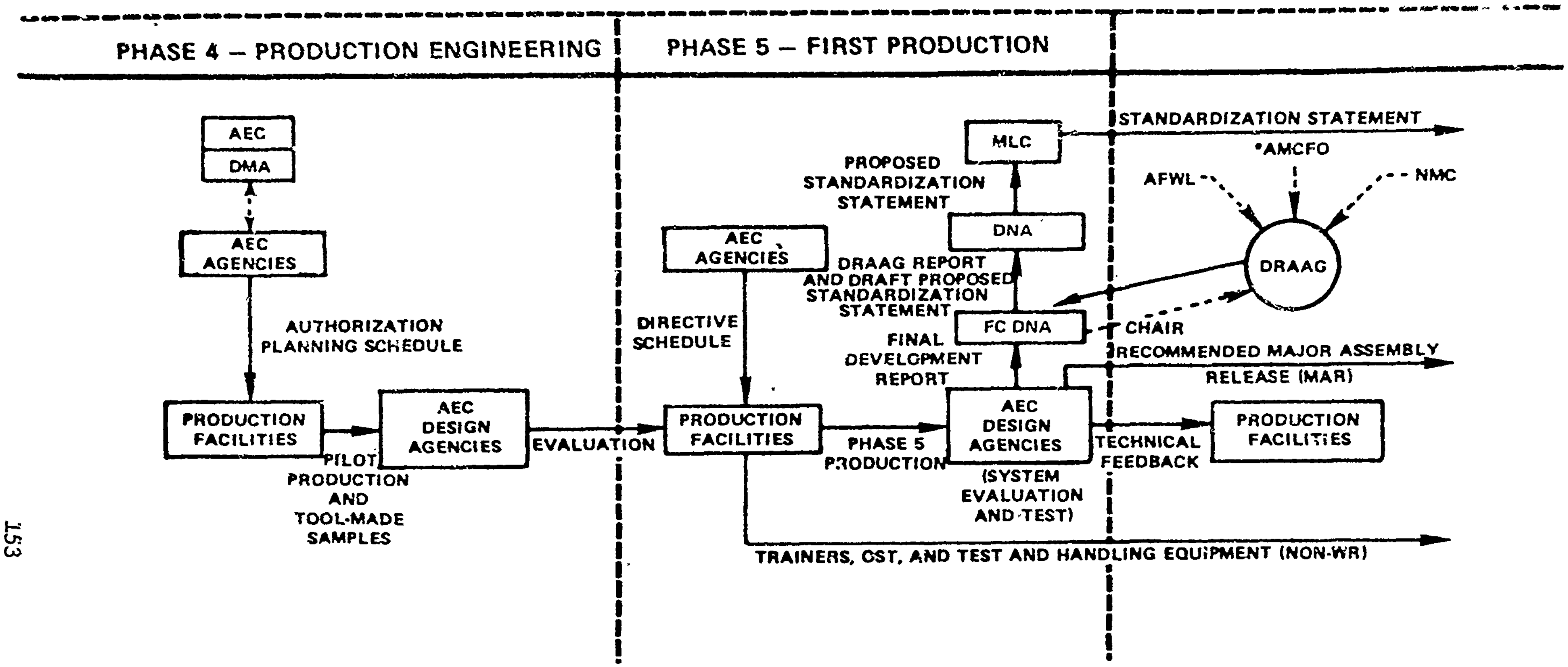

PHASE 4 — PRODUCTION ENGINEERING
PHASE 5 — FIRST PRODUCTION
AEC
DMA
AEC AGENCIES
AUTHORIZATION PLANNING SCHEDULE
PRODUCTION FACILITIES
PILOT PRODUCTION AND TOOL-MADE SAMPLES
AEC DESIGN AGENCIES
EVALUATION
AEC AGENCIES
DIRECTIVE SCHEDULE
PRODUCTION FACILITIES
PHASE 5 PRODUCTION
AEC DESIGN AGENCIES
(SYSTEM EVALUATION AND TEST)
FINAL DEVELOPMENT REPORT
FC DNA
DRAAG REPORT AND DRAFT PROPOSED STANDARDIZATION STATEMENT
DNA
PROPOSED STANDARDIZATION STATEMENT
MLC
STANDARDIZATION STATEMENT
*AMCFO
AFWL
NMC
DRAAG
CHAIR
RECOMMENDED MAJOR ASSEMBLY RELEASE (MAR)
TECHNICAL FEEDBACK
PRODUCTION FACILITIES
TRAINERS, CST, AND TEST AND HANDLING EQUIPMENT (NON-WR)

FIGURE 10

AEC - Nuclear Weapon Development

Development Program Procedures

Figure 11 depicts another view of the entire AEC development program from conception to full production. It should be noted that Phases 3 and 4 overlap and that testing occurs in Phases 3, 4, and 5.

AEC DEVELOPMENT PROGRAM PROCEDURES

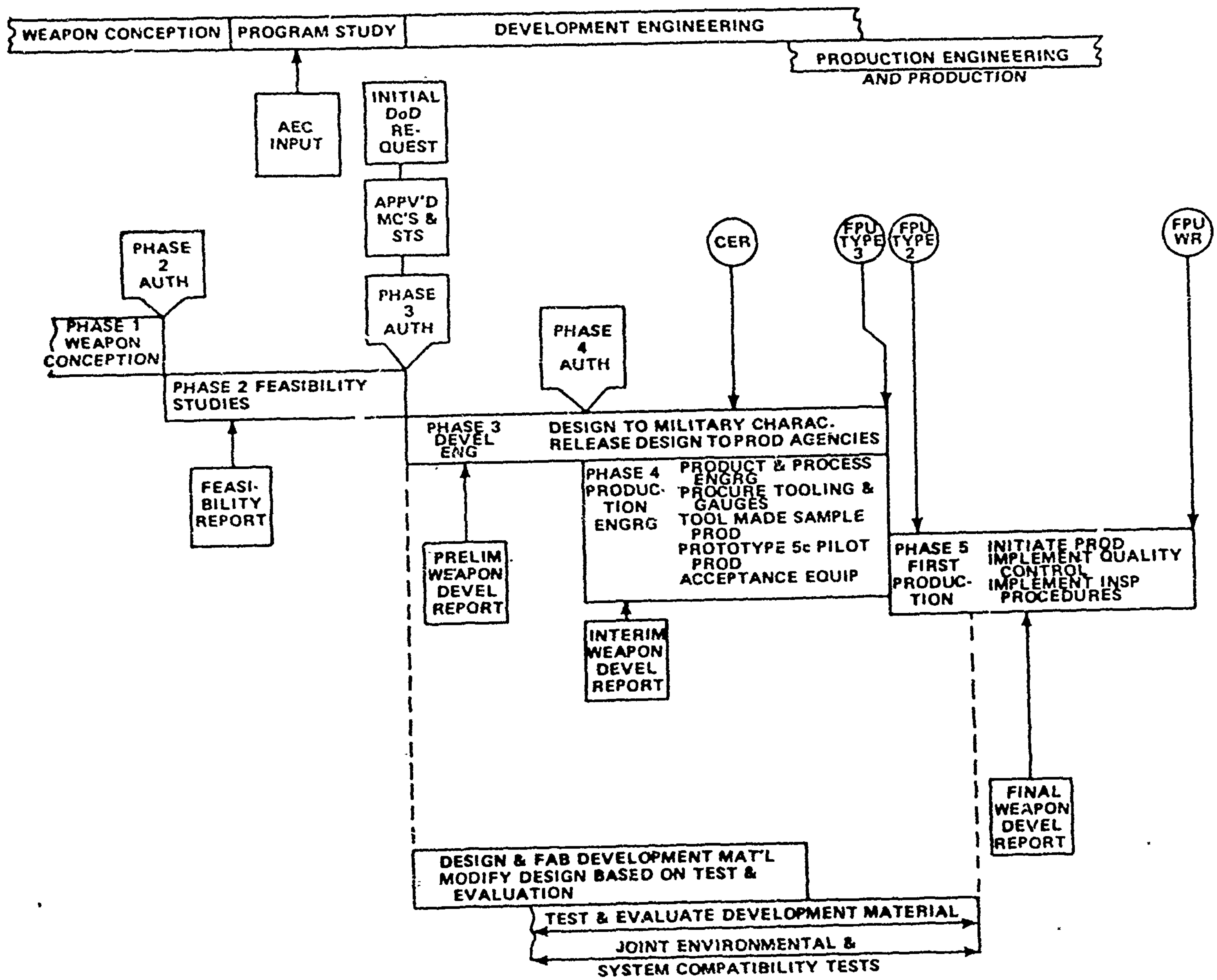


FIGURE 11

A Description of the Formal Interactions Between the DOD and AEC RDTE Systems

As discussed under the AEC formal systems portion of this report, there are rigid formal channels through which all DOD and AEC actions must pass. The MLC (Military Liaison Committee) is the DOD coordinating activity through which all DOD actions must pass if they are to go to AEC. On the AEC side, DMA (Division of Military Application) handles all AEC actions going to DOD.

In terms of information exchanged, DOD must provide AEC with the following:

- Nuclear Weapon Development Guidance
- Phase 2 Development Request
- Development Request with Military Characteristics and Stockpile-to-Target Sequence
- Quantitative Requirements for Joint Recommendations
- Standardization Statement

AEC must provide DOD with:

- Annual Weapon Development Status Report
- Results of Feasibility Study
- Final Development Report
- Production Units

Because each of these actions has been described and its place in the development sequence shown in the discussion of AEC formal systems, the discussion will not be repeated here. The key point to remember in AEC/DOD formal interactions is the fact that the MLC and DMA constitute the single exchange point through which all actions flow.

A DESCRIPTION OF INDUSTRY INTERFACE
WITH THE FORMAL DOD RDTE SYSTEM

Formal Industry Interface with the DOD RDTE System

Industry interacts formally with DOD to conduct Research, and to develop and produce items of equipment for military use. The contact points for industry within DOD are scattered throughout the United States and are many in number. To illustrate how the formal system works, let us assume that a mythical "ZEE" Company is interested in producing a new antitank missile for the Army that we shall call "Missile Y." The missile is unique in that it can be launched from an infantryman's shoulder or fired through a tank gun. It uses a new guidance concept which we shall call the Z-Ray.

Where Zee Company makes its first formal contact with the Army depends on the stage of development at which it becomes interested. Assume that Zee Company, through its company funded, in-house research, accomplishes the scientific breakthrough necessary for a Z-Ray guided missile. With the technology in hand, it looks for appropriate applications and decides that it can develop Missile Y which would provide a major advance in antitank effectiveness. There is, however, no existing Army requirement for such a missile. Zee Company could then prepare a proposed ROC (Required Operational Capability) document and submit it to Department of Army. At DA, the staff office responsible to receive and act on the ROC is the Office of the Chief of Research and Development and Acquisition (OCRDA). OCRDA would in turn forward the proposed ROC to Training and Doctrine Command, where a proponent would be selected, probably the Infantry Center in this case, and the document forwarded there for comment. Since "Missile Y" has a dual application, in that tanks could also employ it, a copy would also be forwarded to the Armor Center for their comment. When the proponent recommends favorable action and obtains concurrence of the other interested parties, to include the materiel developing agency, the document is returned to OCRDA where it becomes established as a valid Army requirement, and funds are sought for its development. Action within DOD now passes to the appropriate commodity command within Army Materiel Command (AMC), in this case the Missile Command (MICOM). Now formal contact transfers from OCRDA to MICOM and would be handled via contract. Since "Missile Y" would be a major system, a Project Manager (PM) would be appointed by DA to serve as the formal point of contact.

The illustration given is an unusual, but possible, case. More likely, the laboratories at MICOM would be aware of the developing technology and by an exchange of information with the using agencies, a ROC would have been in existence by the time Zee Company was ready to contact DA. If so, the point for initial formal contact would not be OCRDA but MICOM, and the formal action could be an unsolicited proposal or a proposal submitted in response to a Request for Proposal (RFP) released by MICOM.

A third case is as likely. If development has reached the Advanced Development or the Engineering Development category and a PM is already appointed, Zee Company's first formal contact may be a response to an RFP released by the PM. In this instance, the point of contact for formal action is the PM's office.

In summary, it can be stated that industry most often makes formal contact with DOD through either a commodity command of AMC or a project manager's office. The forms of documentation for formal action between DOD and members of industry are the RFP, the proposal, and the Government contract. For those rare occasions when a member of industry feels it can develop a totally new item of equipment for which no stated requirement exists, but for which there is a need, there are channels for submission of a ROC direct to DA.

The organization chart in Figure 12 has the points of contact discussed in this section shaded for easy reference.

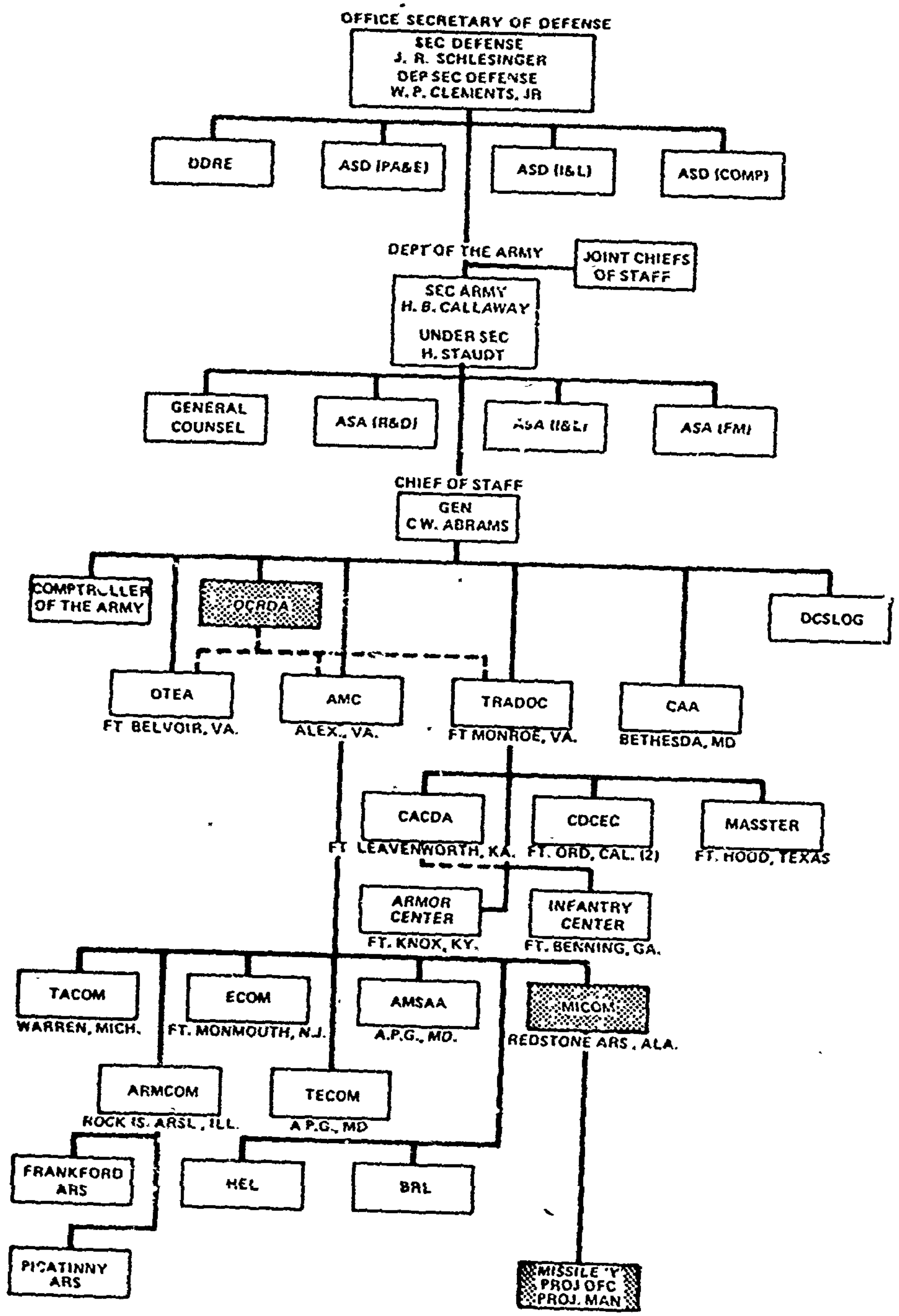

OFFICE SECRETARY OF DEFENSE
SEC DEFENSE
J. R. SCHLESINGER
DEP SEC DEFENSE
W. P. CLEMENTS, JR
DDRE
ASD (PA&E)
ASD (I&L)
ASD (COMP)
DEPT OF THE ARMY
JOINT CHIEFS OF STAFF
SEC ARMY
H. B. CALLAWAY
UNDER SEC
H. STAUDT
GENERAL COUNSEL
ASA (R&D)
ASA (I&L)
ASA (FM)
CHIEF OF STAFF
GEN
C W. ABRAMS
COMPTROLLER OF THE ARMY
OCRDA
DCSLOG
OTEA
FT BELVOIR, VA.
AMC
ALEX., VA.
TRADOC
FT MONROE, VA.
CAA
BETHESDA, MD
CACDA
FT LEAVENWORTH, KA.
CDCEC
FT. ORD, CAL. (2)
MASSTER
FT. HOOD, TEXAS
ARMOR CENTER
FT. KNOX, KY.
INFANTRY CENTER
FT. BENNING, GA.
TACOM
WARREN, MICH.
ECOM
FT. MONMOUTH, N.J.
AMSAA
A.P.G., MD.
MICOM
REDSTONE ARS., ALA.
ARMCOM
ROCK IS. ARSL., ILL.
TECOM
A.P.G., MD
FRANKFORD ARS
HEL
BRL
PICATINNY ARS
MISSILE 'Y' PROJ OFC PROJ. MAN

FIGURE 12

ADDENDUM A

EXPLANATION OF ABBREVIATIONS

ADDENDUM A

Explanation of Abbreviations

AAI	Army Analysis of Intelligence
AD	Advanced Development (RDTE Category 6.3)
ADO	Advanced Development Objective
AEC	Atomic Energy Commission
AFDP	Army Force Development Plan
AFP	Army Force Program
AFWL	Air Force Weapons Laboratory
AMCFO	Army Materiel Command Field Office
ARDIS	Army Research and Development Information System
ASARC	Army Systems Acquisition Review Council
ASCP	Army Strategic Capabilities Plan
ASOP	Army Strategic Objectives Plan
ATSD (AE)	Assistant to the Secretary of Defense (Atomic Energy)
BTA	Best Technical Approach
BY	Budget Year
CER	Complete Engineering Release
CF	Concept Feasibility
CFP	Concept Formulation Package
DA	Department of the Army
DCP	Development Concept Paper
DDPAE	Director of Defense Program Analysis and Evaluation
DDRE	Director of Defense Research and Engineering

DEVA	Development Acceptance
DMA	Division of Military Application
DOD	Department of Defense
DNA	Defense Nuclear Agency
DP	Development Plan
DPPG	Defense Policy and Planning Guidance Memorandum
DRAAG	Design Review and Acceptance Group
DSARC	Defense Systems Acquisition Review Council
DT	Development Testing
ED	Engineering Development (RDTE Category 6.4)
EDG	Exploratory Development Goals
EDR	Exploratory Development Requirements (Navy)
FCDNA	Field Command, Defense Nuclear Agency
FPU, Type 2	First Production Unit, OST
FPU, Type 3	First Production Unit, Trainer
FPUWR	First Production Unit, War Reserve
FY	Fiscal Year
FYDP	Five Year Defense Program
GOR	General Operational Requirements (Navy)
IOC	Initial Operational Capability
IPR	In-Process Review
JCS	Joint Chiefs of Staff
JFM	Joint Force Memorandum
JIEP	Joint Intelligence Estimate for Planning
JLREID	Joint Long Range Estimative Intelligence Document

JLRSS	Joint Long Range Strategic Study
JRDOD	Joint Research and Development Objectives Document
JS	Joint Staff
JSCP	Joint Strategic Capabilities Plan
JSOP	Joint Strategic Objectives Plan
LCMM	Life Cycle Management Model
MAR	Major Assembly Release
MC	Military Characteristics
MLC	Military Liaison Committee
MN	Materiel Need
MS	Management and Support (RDTE Category 6.5)
MUL	Master Urgency List
NMC	Naval Materiel Command
NRR	Naval Research Requirements
OAD	Operational Availability Date
OCO	Operational Capability Objective
OSD	Office of the Secretary of Defense
OST	Operational Suitability Test
OT	Operational Testing
PPBS	Planning, Programming, and Budgeting System
PBD	Program/Budget Decision
PCD	Program Change Decision
PCR	Program Change Request
PDM	Program Decision Memorandum
PMD	Program Management Directive
POM	Program Objective Memorandum

PPGM	Planning and Programming Guidance Memorandum
PV	Production Validation
QCR	Qualitative Construction Requirement
QMDO	Qualitative Materiel Development Objective
QMR	Qualitative Materiel Requirement
QRR	Qualitative Research Requirement for Nuclear Weapons Effects Information
R	Research (RDTE Category 6.1)
RDTE	Research, Development, Test and Evaluation
RO	Research Objective
ROC	Required Operational Capability
RTA	Required Technology Advance
SCO	System Concept Options
SD	Operational Systems Development (RDTE Category 6.7)
SDR	Small Development Requirement
SECDEF	Secretary of Defense
SOR	Specific Operational Requirement (Navy)
STS	Stockpile-to-Target Sequence
TDP	Technical Development Plan (Navy)
TOA	Total Obligational Authority
TSOR	Tentative Specific Operational Requirement (Navy)
VAL	Validation
XD	Exploratory Development (RDTE Category 6.2).

ADDENDUM B

DEFINITION OF TERMS

ARMY STRATEGIC CAPABILITIES PLAN (ASCP): Tab IV to Addendum B.

ARMY STRATEGIC OBJECTIVES PLAN (ASOP): Tab V to Addendum B.

BUDGET COSTS: Costing used in budget submissions as distinguished from costing used in programming documents, referred to as programming costs. Budget costs represent the specific TDA requirements for funds in a particular fiscal period and generally represent a refinement of programming costs.

BUDGET YEAR: That fiscal year arrived at by adding one to the current fiscal year. In fiscal year 1974, the budget year is fiscal year 1975.

CONCEPT FORMULATION PACKAGE (CFP): The documentary evidence that the concept formulation effort has satisfied the concept formulation objectives. The package consists of a Trade-off Determination (TOD), Trade-off Analysis (TOA), Best Technical Approach (BTA), and Cost and Operational Effectiveness Analysis (COEA).

COST CATEGORY: One of three types of costs into which the total cost of a program element is divided: (1) research and development, (2) investment, and (3) operations.

DEVELOPMENT CONCEPT PAPER (DCP): A document prepared by the Director of Defense Research and Engineering (DDR&E) and coordinated with key DoD officials providing a summary management document for the Secretary of Defense. DCPs reflect the Secretary of Defense decisions on important development and engineering modification programs. The document serves as a source of primary information and rationale and for updating the FYDP. (See Tab XX to Appendix B).

DEFENSE POLICY AND PLANNING GUIDANCE MEMORANDUM (DPPC): Tab VI tc Addendum B.

DEFENSE SYSTEMS ACQUISITION REVIEW COUNCIL (DSARC): Review of major programs by OSD (if required) is accomplished through use of the DSARC. The council is an OSD advisory body consisting of the Director of Defense Research and Engineering and the Assistant Secretaries of Defense (Installations and Logistics, Comptroller, and Systems Analysis; and for their particular programs, Intelligence and Telecommunications). The council recommends a course of action and the actual decision is made by the Secretary or Deputy Secretary of Defense.

DEVELOPMENT PLAN (DP): The document of record which reflects all phases of planning and program execution. It is prepared for all RDTE programs in the advanced development, engineering development, or operational systems development categories.

DEVELOPMENT TESTING (DT): Development Testing uses scientific and engineering methods, and involves collection of precise data, in order to -

(1) Assess technical risks involved in a candidate development program.

(2) Demonstrate that engineering design is complete and acceptable.

(3) Determine whether design risks have been eliminated or are manageable

(4) Measure the performance of a system and determine the degree to which the performance meets stated specifications or characteristics (to include technical reliability, availability, and maintainability).

(5) Estimate whether a system can be produced within forecast time and cost constraints. (See Tab XXI to Addendum B)

EXPLORATORY DEVELOPMENT (XD): Includes all efforts directed toward solving specific military problems short of major development efforts. It may vary from fairly fundamental applied research to quite sophisticated prototype hardware, study, programming, and planning efforts. It would thus include studies and minor development efforts. The dominant characteristic is that the effort is pointed toward specific military problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions and determining their parameters. Program control is normally exercised by general level of effort.

ENGINEERING DEVELOPMENT (ED): Includes those development projects which are being engineered for military service use, but have not yet been approved for procurement or operations. It is characterized by major line item projects, and program control is exercised by reviewing individual projects.

FISCAL YEAR (FY): The year beginning 1 July before the beginning of each calendar year. FY 1974 is the period, 1 July 1973 - 30 June 1974.

FIVE YEAR DEFENSE PROGRAM (FYDP): Tab VII to Addendum B.

JOINT CHIEFS OF STAFF (JCS): The Chairman, the Army Chief of Staff, the Chief of Naval Operations, the Air Force Chief of Staff, and the Commandant of the Marine Corps. Frequently, the term and abbreviation are used in referring to the entire organization of the Joint Chiefs of Staff and/or to

the Joint Staff which serves the Joint Chiefs of Staff when they are performing their joint functions. As used herein, the abbreviation, JCS, is used to represent an agency only when the Joint Chiefs of Staff, as a corporate body, normally act on the item in question.

JOINT FORCE MEMORANDUM (JFM): Tab VIII to Addendum B.

JOINT INTELLIGENCE ESTIMATE FOR PLANNING (JIEP): Tab IX to Addendum B.

JOINT LONG RANGE ESTIMATIVE INTELLIGENCE DOCUMENT (JLREID): Tab X to Addendum B.

JOINT LONG RANGE STRATEGIC STUDY (JLRSS): Tab XI to Addendum B.

JOINT RESEARCH AND DEVELOPMENT OBJECTIVES DOCUMENT (JRDOD): Tab XII to Addendum B.

JOINT STAFF (JS): The staff, limited by law to approximately 400 offices, from all of the military services which provides staff services to the Joint Chiefs of Staff.

JOINT STRATEGIC CAPABILITIES PLAN (JSCP): Tab XIII to Addendum B.

JOINT STRATEGIC OBJECTIVES PLAN (JSOP): Tab XIV to Addendum B.

MANAGEMENT AND SUPPORT (MS): Includes research and development effort directed toward supporting installations or operations required for general research and development use. Included would be test ranges, minor construction provided for under title 10 U.S.C. 2674 costing less than $50,000, maintenance support of laboratories, and operations and maintenance of test aircraft and ships. Costs of laboratory personnel, either in-house or contract-operated,

would be assigned to appropriate projects or as a line item in the research, exploratory development, or advanced development areas. Minor construction costing less than $50,000 directly related to a specific development program will be included in the appropriate element.

MAJOR PROGRAM: A program so designated by the Secretary of Defense. Considerations in this designation include:

(1) Dollar value, estimated RDTE cost in excess of $50 million, production cost in excess of $200 million;
(2) National urgency; and
(3) Recommendation by senior officials.

MATERIEL NEED (MN): An obsolete form of a statement for an Army materiel requirement. The MN has been superceded by the ROC.

NUCLEAR ANNEX TO THE JOINT FORCE MEMORANDUM: Tab XV to Addendum B.

NUCLEAR WEAPON DEVELOPMENT GUIDANCE (NWDG): Tab XVI to Addendum B.

OPERATIONAL CAPABILITY OBJECTIVE (OCO): A Department of Army approved document describing an operational capability desirable of achievement in a specified timeframe, 10 or more years in the future.

OPERATIONAL SYSTEMS DEVELOPMENT (SD): This category is not defined as an R&D category in the Five-Year Defense Program (FYDP) program element structure. It represents a convenience grouping of major line item projects which appear as the RDTE cost of weapons system elements funded in programs other than Program 6. The "category" includes research and development effort directed

toward development, engineering, and test of systems, support programs, vehicles, and weapons. Program control is exercised by reviewing the individual research and development effort contained within the basic program element for the operational system.

OPERATIONAL TESTING (OT): Operational Testing is accomplished in as realistic an operational environment as possible, to determine for a system -

(1) Its military utility, operational effectiveness and operational suitability (including reliability, maintainability and logistic and training requirements).

(2) Whether from the user viewpoint the new system is desirable considering equipment already available and the benefits/burdens associated with the new system.

(3) The need for any modifications.

(4) Adequacy of organization, doctrine, and tactics for its employment. (See Tab XXII to Addendum B.)

PLANNING/PROGRAMMING BUDGETING SYSTEM: An integrated system for the establishment, maintenance, and revision of the FYDP and the DoD budget.

PLANNING AND PROGRAMMING GUIDANCE MEMORANDUM: Tab XVII to Addendum B.

PROGRAM: A combination of program elements designed to express the accomplishment of a definite objective or plan which is specified as to the time-phasing of what is to be done and the means proposed for its accomplishment. Programs are aggregations of program elements, and, in turn, aggregate to the total FYDP.

PROGRAM/BUDGET DECISION (PBD): A Secretary of Defense decision in prescribed format authorizing changes to a submitted budget estimate and the FYDP. It is used to announce all budget decisions incident to the annual review of the formal SECDEF budget submission.

PROGRAM/BUDGET REVIEW SCHEDULE: An annual Secretary of Defense memorandum issued to announce the schedule of significant events impacting on the DoD decision-making cycle.

PROGRAM CHANGE DECISION (PCD): A Secretary of Defense decision, in prescribed format, authorizing changes to the Five Year Defense Program. PCDs are formatted to make them compatible with PCRs.

PROGRAM CHANGE REQUEST (PCR): Proposal in prescribed format for out-of-cycle changes to the approved data in the Five Year Defense Program.

PROGRAM DECISION MEMORANDUM (PDM): Tab XVIII to Addendum B.

PROGRAM ELEMENT: A description of a mission by the identification of the organizational entities and resources needed to perform the assigned mission. Resources consist of forces, manpower, material quantities, and costs, as applicable. The program element is the basic building block of the FYDP.

PROGRAM OBJECTIVE MEMORANDUM (POM): Tab XIX to Addendum B.

PROGRAM YEAR: A fiscal year in the Five Year Defense Program that ends not earlier than the second year beyond the current calendar year. Thus, during calendar year 1974, the first program year is FY 1976.

RESEARCH (R): Includes scientific study and experimentation directed toward increasing knowledge and understanding in those fields of the physical, engineering, environmental biomedical, and behavioral-social sciences related to national security needs. It provides fundamental knowledge for the solution of identified military problems. It also provides part of the base for subsequent exploratory and advanced developments in the defense-related technologies of new or improved military functional capabilities, such as communications, detection, tracking, surveillance, propulsion, mobility, guidance and control, navigation, energy conversion, materials and structures, and personnel support.

RESEARCH, DEVELOPMENT, TEST AND EVALUATION (RDTE): RDTE is the orderly process of materiel development that encompasses all activities from conception to the decision to enter production, and the improvement of existing systems when that improvement significantly upgrades performance capability. It includes but is not limited to basic research, experimentation, design, fabrication of prototypes and testing.

REQUIRED OPERATIONAL CAPABILITY (ROC): A brief document which describes in narrative form the <u>minimum essential</u> operational, technical, and cost information required for a HQDA decision to initiate development of a new materiel system.

SYSTEM/PROJECT MANAGEMENT. This concept uses a designated system/project manager, chartered by the Secretary of the Army, who is responsible for planning, organizing, directing, and controlling all phases of the development effort and initial procurement, production, distribution, and logistical support. The manager is supported by functional organizations, which are responsible for the execution of specifically assigned tasks (AR 70-17).

TOTAL OBLIGATIONAL AUTHORITY (TOA): The total financial requirements of the Five Year Defense Program or any component therof required to support the approved program of a given fiscal year.

TAB I TO ADDENDUM B

ARMY ANALYSIS OF INTELLIGENCE (AAI)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
Army	Annual	Long, Mid, and Short Range	I-Short Range II-Mid Range III-Long Range

SYNOPSIS:

1. Provides the basic threat analysis for use by the Army staff and by Army commands worldwide.
2. Presents threat analyses based upon intelligence produced by the national and defense intelligence communities. These analyses provide a basis for Army contributions to joint strategic planning, as well as a basis for the development of Army strategic plans, studies, analyses, and war games.
3. Identifies gaps in required intelligence and the intelligence community is requested to produce the intelligence.

TAB II TO ADDENDUM B

ARMY FORCE DEVELOPMENT PLAN (AFDP)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
Army	Annual	Mid and Short Range	1

SYNOPSIS:

1. Structures the Army approved force in detail for the year following the budget year and gross structures the approved force for four additional years.
2. Proposes the modernization for the Army for a 10 year period following the budget year.
3. Develops major materiel and systems modernization plans.
4. Analyzes the approved force for deficiencies and proposes corrective action concerning organizational changes, modernization, and new doctrine.
5. Provides a sound analytical base for Army participation in the OSD and joint planning, programming and budget cycles.

TAB III TO ADDENDUM B

ARMY FORCE PROGRAM (AFP)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
Army	Continually Updated	Mid and Short Range	1

SYNOPSIS:

1. Develops in detail the Army force structure approved by the SECDEF for the current and budget years.
2. Develops a balanced Army force that can be supported with sufficient resources to permit the attainment of authorized levels of organization (ALO).
3. Establishes the active Army approved force (troop list) for the current and budget years.
4. Establishes active Army military and civilian manpower programs for the current and budget years.
5. Identifies in detail the reserve components force structure.
6. Develops force programming guidance for the Army staff and Army operating commands and agencies.
7. Provides a projection of asset demands and availability allowing DA to assess its capability to support the force.
8. Presents a schedule of activations, inactivations, reorganizations, and deployments.
9. Supports the Army budget request through the entire budget cycle.

TAB IV TO ADDENDUM B

ARMY STRATEGIC CAPABILITIES PLAN (ASCP)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
Army	Annual	Short Range	1

SYNOPSIS:

1. Provides guidance to Army agencies, Army commands, Army component commands of unified commands for the employment and/or support of Army forces.
2. Uses the planning assumptions of, and is an Army complement to, JSCP.
3. Assigns missions to Army major commands not otherwise assigned missions by unified commands.
4. Documents active Army forces available to execute contingency plans.
5. Presents the mobilization schedule and forces together with planned availability for deployment of these forces.
6. Presents the joint strength concept and planning guidance.
7. Assigns tasks to Army commanders and Army component commanders.
8. Assign[illegible] [illegible]ions in CONUS and overseas to include mobilization a[illegible] deployments.
9. Pres[illegible] [illegible]dance and instructions for Army forces.
[illegible] [illegible]licies and instructions for civilian and [illegible]ations, with or without mobilization.

TAB V TO ADDENDUM B

ARMY STRATEGIC OBJECTIVES PLAN (ASOP)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
Army	Annual	Mid Range	I-Strategy II-Analyses and Force Tabulations

SYNOPSIS:

1. Provides basis for Army inputs to JSOP, JLRSS, JRDOD.
2. Provides basis for Army inputs to the JFM and the POM.
3. Reflects in Volume I, which is developed parallel to JSOP Volume I, the JCS approved strategy translated to Army terms.
4. Contains in Volume II the Army recommended force objectives and resource requirements to execute the approved strategy.

TAB VI TO ADDENDUM B

DEFENSE POLICY AND PLANNING GUIDANCE MEMORANDUM (DPPG)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
OSD	Annual	Mid Range	1

SYNOPSIS:

1. Considers military objectives, military appraisal, strategic concept and force planning guidance of Volume I of JSOP.
2. Contains guidance on strategic concepts for the JCS and the services.
3. Updates and/or enlarges upon JSOP I strategy based on changes in national security objectives or presidential commitments.
4. Provides definitive guidance for DoD force planning including the development of JSOP Volume II.
5. Identifies issues for selected analysis in developing the defense budget.

TAB VII TO ADDENDUM B

FIVE YEAR DEFENSE PROGRAM (FYDP)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
OSD	Annual	Mid Range	1

SYNOPSIS:

1. Is the official program of the DoD for defining the approved force structure and the resources for its support.
2. Is a programming system for review and approval of proposed DoD programs and, on a continuing basis, proposed changes to previously approved programs.
3. Is the official publication which summarizes the approved plans and programs of the DoD components.
4. Includes cost data for the current fiscal year, the base fiscal year plus 4 succeeding fiscal years.
5. Includes force structure data for the current fiscal year, the base fiscal year plus 7 succeeding fiscal years.
6. Is changed by means of program change requests initiated by elements of OSD or the service secretaries with the approval of SECDEF as announced in PCD, the PPGM or the PBD.

TAB VIII TO ADDENDUM B

JOINT FORCE MEMORANDUM (JFM)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
JCS	Annual	Mid Range	1

SYNOPSIS:

1. Considers the JSOP; DPPG; the prior year five year defense program; and particularly the force planning, fiscal, and materiel support guidance in the PPGM.
2. Provides the SECDEF with constrained force levels, within major mission and support categories, developed within the parameters of the fiscal guidance issued by the SECDEF.
3. Includes a summary of analyses and assessment of risks associated with the constrained forces as measured against the strategy and military objective in JSOP (Volume I) and the prior guidance of the SECDEF.
4. Highlights major force issues which require decisions during the current year, includes program costs and associated manpower requirements provided by the services, and compares costs of the constrained force levels and the support programs with the costs of the approved baseline.
5. Contains R&D Annex providing the views of the JCS on the R&D objectives to be pursued within the guidance and fiscal constraints issued in the PPGM and on the resolution of statements of R&D priorities contained in the JRDOD.

TAB IX TO ADDENDUM B

JOINT INTELLIGENCE ESTIMATE FOR PLANNING (JIEP)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
JCS	Annual	Short and Mid Range	I-Short Range II-Mid Range

SYNOPSIS:

1. Summarizes factors affecting world power relationships.
2. Includes regional intelligence estimates.
3. Assesses likely courses of action of nations in the region.
4. Assesses future direction and effectiveness of regional treaty organizations.
5. Forecasts likely areas of conflict, objectives of opposing sides, and estimate of scope and intensity of conflict.

TAB X TO ADDENDUM B

JOINT LONG RANGE ESTIMATIVE INTELLIGENCE DOCUMENT (JLREID)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
JCS	Annual	Long Range	1

SYNOPSIS:

1. Provides principal intelligence basis for development of JLRSS and long range period JRDOD.
2. Summarizes factors and trends affecting world power relationships in long range period (10-20 years).
3. Provides intelligence estimates of capabilities of selected nations to affect the national interests of the United States.

TAB XI TO ADDENDUM B

JOINT LONG RANGE STRATEGIC STUDY (JLRSS)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
JCS	Bi-Annual	Long Range	1

SYNOPSIS:

1. Provides a source document including representative environmental projections and useful analyses of trends and relationships.
2. Addresses the strategic implications of worldwide and national economic, political, social, technical, and military trends and considers their impact on national objectives, policies, and military constraints.
3. Stimulates more sharply focused strategic studies for developing military policies, plans, and programs having long range implications.
4. Includes a strategic appraisal of the major political, ideological, military, socio-economic, and techno-scientific factors and trends which are expected to influence the world environment over the long term.
5. Includes a consideration of the probable major world power groupings, including alternative power alignments, and a listing of possible conflict situations.
6. Includes a broad description of the capabilities that the U.S. Armed Forces should possess in order to serve as an instrument of national policy in the long range period.
7. Includes a correlation of the anticipated U.S. military capabilities with major research and development goals in terms of required long range operational capabilities.

TAB XII TO ADDENDUM B

JOINT RESEARCH AND DEVELOPMENT OBJECTIVES DOCUMENT (JRDOD)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
JCS	Annual	Mid and Long Range	1

SYNOPSIS:

1. Translates the broad strategic implications of U.S. military capabilities projected in the JLRSS, the strategic appraisal and concept, objective force levels, and functional area requirements of the JSOP into research and development (R&D) objectives in order to provide advice and assistance to the Secretary of Defense in developing the DoD R&D program.
2. Contains R&D objectives which are responsive to the strategy and force recommendations in the JSOP.
3. Contains R&D objectives, based on broad trends and future technologies, required to furnish military forces with the capabilities needed to execute the military role prescribed for them in the long range period by the JLRSS.
4. Contains a listing of the R&D objectives considered essential to support the mid range strategy and the military objectives of the JSOP, the needs of the commanders of the unified and specified commands, and the needs of the national authorities.
5. Contains rationale to support the R&D objectives recommended.

TAB XIII TO ADDENDUM B

JOINT STRATEGIC CAPABILITIES PLAN (JSCP)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
JCS	Annual	Short Range	I-Concept, Tasks, Planning Guidance II-Forces

SYNOPSIS:

1. Provides guidance to commanders of unified and specified commands and to chiefs of services based on projected military capabilities and conditions.
2. Contains strengths based on projected available forces to support the national security objectives and the military objectives derived therefrom.
3. Includes planning guidance on forces, logistics, intelligence, and the development of multilateral and bilateral plans.

TAB XIV TO ADDENDUM B

JOINT STRATEGIC OBJECTIVES PLAN (JSOP)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
JCS	Annual	Mid Range	I-Strategy II-Analyses and Force Tabulations

SYNOPSIS:

1. Considers President's Foreign Policy Report, National Security Decision Memoranda, Secretary of Defense decisions and guidance, current intelligence, and Joint Chiefs of Staff Decisions in developing Volume I. Considers National Security Policy and Strategy and the Planning Principles and Force Planning Guidance of the Defense Policy and Planning Guidance in developing Volume II.
2. Provides advice to the President and the SECDEF on military strategy and force strength requirements for attaining the national security objective of the U.S.
3. Recommends objective force levels to SECDEF.
4. Appraises programmed force.
5. Provides military risk evaluation.
6. Serves as a basis of consideration in connection with preparation of the DPPG, PPGM, JFM, POM, FYDP, and the defense budget.
7. Provides planning guidance for commanders of the unified and specified commands and the chiefs of the services.
8. Covers period from 1 July two years subsequent to the base date (always 1 July of the current fiscal year) and extending for eight years thereafter.

TAB XV TO ADDENDUM B

NUCLEAR ANNEX TO THE JOINT FORCE MEMORANDUM

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
JCS	Annual	Mid-Range	1

SYNOPSIS:

1. Considers the views of the Services and the Unified and Specified Commanders, the production capabilities of the Atomic Energy Commission, the annual Nuclear Weapon Development Guidance, the Nuclear Annex to the JSOP, and the forces in the JSOP and JFM.
2. Provides the views of the JCS to SECDEF on future nuclear weapon stockpile requirements, consistent with fiscal constraints, to support the JFM.
3. Is the primary basis for the Secretary of Defense position on the Presidential Stockpile Memorandum which is jointly submitted annually by the SECDEF and the Chairman, AEC, to the President for his approval.

TAB XVI TC JENDUM B

NUCLEAR WEAPON DEVELOPMENT GUIDANCE (NWDG)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
JCS	Annual (CY)	Long, Mid, and Short Range	1 (seven parts)

SYNOPSIS:

1. Considers the annual AEC Development Report; the views of the Services, the Unified and Specified Commanders, and the Director, Defense Nuclear Agency; and the forces in the JSOP and JFM.
2. Provides development objectives, as opposed to requirements, to the SECDEF including a summary table of development objective views of the Unified and Specified Commanders or development objectives documented in other publications of the JCS.
3. Is primary basis for annual Memorandum from the Secretary of Defense to the Chairman, AEC, on this subject.
4. Summarizes potential qualitative requirements for nuclear weapons of the Department of Defense.
5. Identifies technological goals in support of future weapon developments.

TAB XVII TO ADDENDUM B

PLANNING AND PROGRAMMING GUIDANCE MEMORANDUM (PPGM)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
OSD	Annual	Mid-Range	1

SYNOPSIS:

1. Considers the major force requirements, objective force levels, appraisals and risk evaluation of the JSOP and the research and development objectives of the JRDOD.
2. Provides the secretaries of the military departments, JCS and defense agencies with the following guidance:
   A. Force Planning Levels
   B. Fiscal Levels
   C. Materiel Support Planning [illegible]dance
3. Provides the basic guidance for the development of the JFM and the POM.

TAB XVIII TO ADDENDUM B

PROGRAM DECISION MEMORANDUM (PDM)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
OSD	Annual	Mid-Range	1

SYNOPSIS:

1. Considers the JSOP, the fiscally constrained forces and the appraisal of risks in the JFM, the POM's, and the selected analyses of all agencies.
2. Contains a "Resource Annex" which provides a translation of resources to program elements in the FYDP.
3. Transmits SECDEF decision to the JCS, military departments and defense agencies as appropriate for analysis, the submission of comments, and updating of the FYDP.

TAB XIX TO ADDENDUM B

PROGRAM OBJECTIVE MEMORANDUM (POM)

Responsible Agency	Production Schedule	Period(s) Addressed	Number of Volumes and Titles
Army	Annual	Mid-Range	1

SYNOPSIS:

1. Is based on JSOP as modified by the DPPG and the PPGM.
2. Expresses total program requirements, provides force, manpower cost and materiel recommendations, and rationale for proposed changes from the approved FYDP and the JFM, and the risk assessment within the parameters of the published SECDEF fiscal guidance.
3. Contains supporting information in program element terms.
4. Is submitted by the secretary of a military department or the director of a defense agency.

TAB XX TO ADDENDUM B

OUTLINE DEVELOPMENT CONCEPT PAPER

I. Nature of the Program - A brief statement of why the system is needed, what will be accomplished by the successful completion of the program, to include items in the current inventory that will be replaced and the best estimate of the quantities of the new system to be fielded. The threat should be discussed in this section.

II. Background - Summary of the development history, past decisions, sunk costs, and testing results.

III. Management Issues - The key issue or issues that the paper addresses and any issues that may arise before the next major milestone.

IV. System/Program Alternatives - A comparison of alternatives will address the following:

   A. Technical and Operational Characteristics.
   B. Costs, Funding and Cost Effectiveness.
   C. Schedules and Milestones.
   D. Risks.
   E. Reliability, Availability, Maintainability and Durability.
   F. Impact on Force Design and Quantities of System Required.

V. Assessment of Program Alternatives with Recommendations.

VI. Cost, Schedule, and Performance Thresholds - Those critical aspects of the program that, if not met, would be sufficient cause to reconsider the decision rendered. If appropriate, the "design to" parameters of the system will be included in this section.

VII. Test and Evaluation - A summary of the plan for test and evaluation stating the objectives of each test planned and the critical issues to be resolved by each.

VIII. Logistical Support - A summary of the plan for Integrated Logistics Support (ILS) and critical issues of supportability.

IX. Security Classification Guidelines.

TAB XXI TO ADDENDUM B

DEVELOPMENT TESTING

a. General

(1) DT should be started as early in the development cycle as possible and should first test components, then subsystems, and finally prototypes or preproduction models of the entire system. Previously acquired test data which can be validated, regardless of source, will be used whenever applicable. DT will include "soldier proofing" through participation of representative user personnel. DT test results, reports and evaluations will be distributed in a manner to assure timely review by commands and agencies involved in the decision-making process.

(2) During advanced development, adequate DT should be accomplished to demonstrate that the technical risks have been identified and are manageable.

(3) During engineering development and prior to the first major production decision, the DT accomplished should be adequate to insure that the engineering is reasonably complete; that all significant design problems (including reliability, maintainability, and logistical considerations) have been resolved; that manufacturing methods and production engineering data have been generated; and that production planning has been completed to the extent required to provide a realistic basis for estimating costs and delivery schedules.

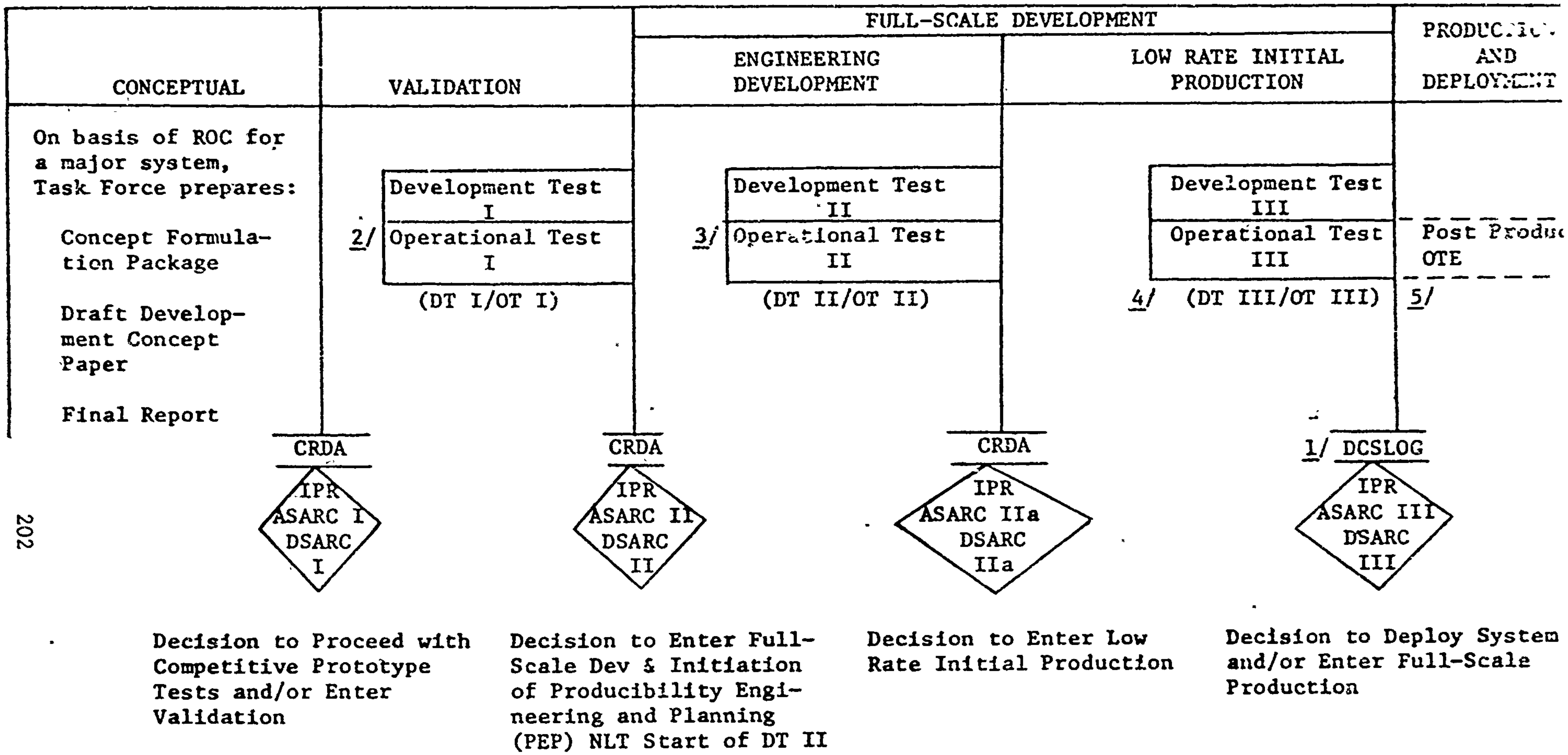
(4) Early production models should be subjected to DT to assure that the characteristics of the production item meet the specifications prescribed.

b. Development Test I (DT I). This test is conducted early in the development cycle, normally during the Validation Phase. Components, subsystems, or the entire system is examined to determine whether the system is ready for Full-Scale Development. This test may, in the case of competitive systems, provide a comparison between the systems tested. Where appropriate, operational testing is conducted concurrently with this test.

c. Development Test II (DT II). This test provides the technical data necessary to assess whether the system is ready for production. It measures the technical performance and safety characteristics of the item and its associated tools, test equipment, training package, and maintenance test package as described in the DP. Technical reliability and maintainability will also be assessed during this test. The test encompasses all the elements of the formerly designated Engineering Test/Expanded Service Test (ET/EST) except for the field test wiht a troop unit. DT II will include "soldier-proofing" by representative user personnel but not necessarily in a truly operational environment. Operational testing is normally conducted concurrently with DT II by the designated command or agency in coordination with the materiel developer's test command.

d. Development Test III (DT III). This test is conducted on systems from the initial production run to verify that the system meets the specifications prescribed for it. The test also serves to confirm that deficiencies found in DT II have been corrected and has the same scope and purpose as specified in AR 70-10 for the Initial Production Test. For Commercial Non-Developmental Items (CNDI), a DT III type test will provide the basis to evaluate the conformance of the commercial system to the specifications of the contract and the requirements of Section II of the DP.

ARMY DEVELOPMENT TEST/OPERATIONAL TEST PROCESS



NOTES:

1/ Applies to responsibility for ASARC/DSARC. CRDA monitors IPR.
2/ Competing systems are tested to determine if gross specifications are met. Initial OT performed to assess init[illegible] effectiveness and suitability.
3/ DT II and OT II serve as a basis for decision to enter Low Rate Initial Production.
4/ DT III and OT III demonstrate production units have capabilities demonstrated in prototypes and are operational[illegible] suitable and effective.
5/ OTE continues throughout life of system. May provide basis for production improvement and other system modifi[illegible]tions.

e. Other Development-type Testing. There are other types of technical tests which the materiel developer conducts as part of materiel system acquisition or in the examination of materiel systems of interest to the Army. Examples are those previously designated as Engineer Design Tests (EDT), Contractor Demonstrations, Research and Development Acceptance Tests (RDAT), and Pre-Production Tests (PPT). Other technical testing and assessments of systems developed by another Service, foreign ally, or commercially which may provide input for a new RCC or development plan will be included in this category.

TAB XVII TO ADDENDUM B

OPERATIONAL TESTING

a. General: OT is conducted as necessary and as early as practicable, beginning with early prototypes and continuing through production. OT will be accomplished by user and support personnel of the type and qulaifications of those expected to use and maintain the system when deployed. OT will normally be conducted in phases, each keyed to the appropriate decision point. OT test results, reports and evaluations will be distributed in a manner to assure timely review by commands and agencies involved in the decision-making process.

b. Operational Test (OT I). This test provides early information as to system operational suitability, and a comparison to existing systems, in order to assist in determining whether the system should enter Full-Scale Development. OT I may also help identify or refine critical issues to be examined in subsequent operational testing. In those cases where the opportunity exists for the conduct of OT I - for example, where competitive prototypes or well advanced prototypes exist - it will be conducted concurrently with DT I using a single, coordinated test plan.

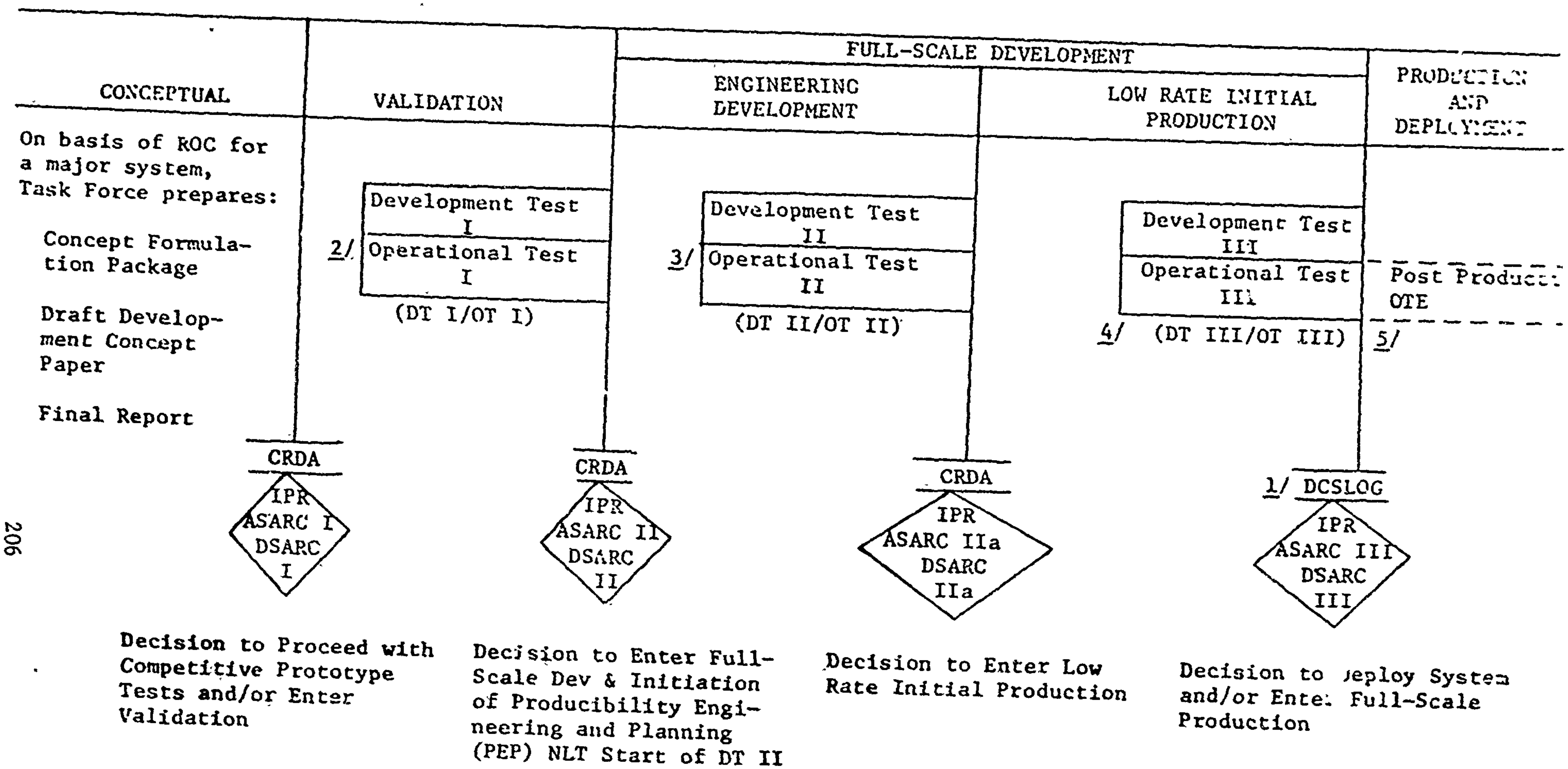
c. Operational Test II (OT II). This test is accomplished prior to the production decision (ASARC IIa/DSARC IIa for major systems) and provides an assessment of system operational suitability and effectiveness. It also provides information needed to refine or validate organizational and employment concepts and determine training and logistic requirements. OT II is normally accomplished concurrently with DT II, using complete preproduction prototypes. Complete interchange of information and data obtained during DT II and OT II is mandatory.

During OT II, the system is subjected to a realistic operational environment, using a small troop unit typical of that which will ultimately be equipped with the system. OT II will produce sufficient and timely results to allow for an independent evaluation to be available to assist in making a Low Rate Initial Production decision at ASARC IIa/DSARC IIa for major systems, or a production recommendation at the IPR for other systems. The DA letter authorizing development of non-major systems will specify the command to conduct OT II.

d. Operational Test III (OT III). This test is accomplished using early production models and provides information to refine or validate earlier estimates of operational effectiveness, to determine the operational suitability of the production model, to optimize organization and doctrine, to validate training and logistic requirements, and to identify any additional actions that should be taken before the new system is deployed.

e. Other Operational-type Testing. There are other types of operational tests which the user may conduct at any time during the materiel life cycle and which relate to operational suitability or operational effectiveness of a system.

ARMY DEVELOPMENT TEST/OPERATIONAL TEST PROCESS



NOTES:

1/ Applies to responsibility for ASARC/DSARC. CRDA monitors IPR.
2/ Competing systems are tested to determine if gross specifications are met. Initial OT performed to assess initial effectiveness and suitability.
3/ DT II and OT II serve as a basis for decision to enter Low Rate Initial Production.
4/ DT III and OT III demonstrate production units have capabilities demonstrated in prototypes and are operationally suitable and effective.
5/ OTE continues throughout life of system. May provide basis for production improvement and other system modifications.

APPENDIX C

Defense RDT&E Policies

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Defense RDT&E Policies

An examination of current RDT&E policies, and a measure of their potential impact upon future program formulation, is important to the understanding of defense RDT&E strategy and the parameters used to formulate strategy. Since policy carries the connotation of a periodically approved approach to the implementation of R&D efforts, it is also necessary to discern the origins and timing of each element in past policies. Some policies can be clearly associated with external factors such as threats, whereas other elements tend to reflect constraints on the activity such as budgetary limitations and management edicts. Six major policy elements have been identified; these are requirements policies, functional division policies, cooperative policies, program implementation policies, program management policies, and performer policies. These policy elements not only characterize the RDT&E world and the dialogue of that world but also provide a mechanism by which strategy can be communicated and implemented.

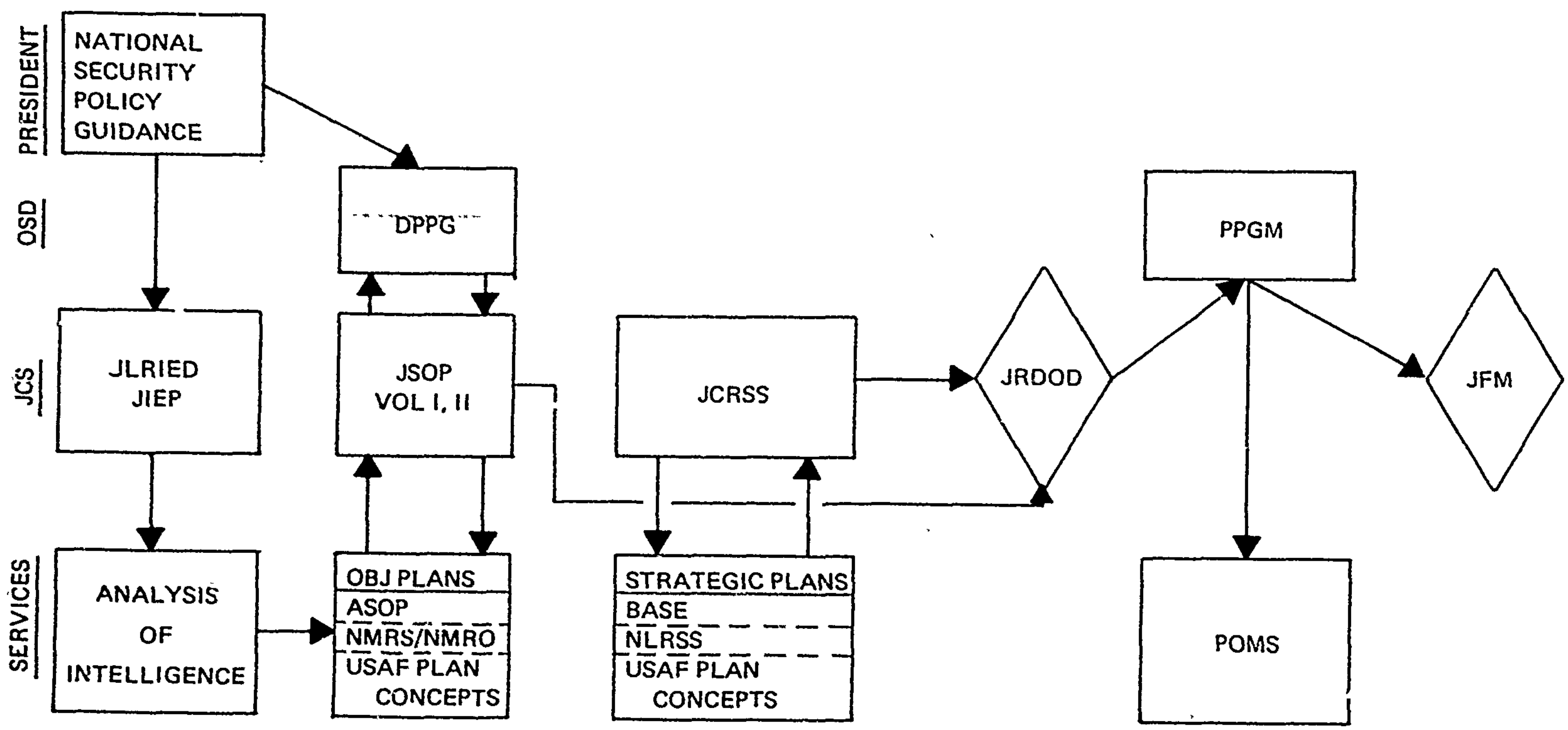
I REQUIREMENTS

A. Background: The Requirements Formulation Process

The Department of Defense (DOD) processes for formulating RDT&E requirements can be initiated by many diverse stimuli, some being in direct response to known or anticipated military threats. Other prominent initiators are breakthroughs in the technological base of the RDT&E program which result in unanticipated opportunities to enhance military operational capabilities. Requirements themselves are expressions of defense needs that are translated into detailed specifications; these are then used as the basis for initiating the development of weapons systems, equipments, or components, or to undertake research on various segments of the scientific spectrum.

The DOD Planning, Programming and Budgeting System (PPBS) provides a starting point for describing the current system for formulating RDT&E requirements. An illustration of the abbreviated cycle is shown in Figure 1 to display the major relationships between the DOD planning cycle and the development of the Joint Research and Development Objective Document (JRDOD). This annually updated document is of major importance in the preparation of Service requirements, since it responds to the dynamics of national security policy, strategic planning, and intelligence estimates. Each of the Services has a family of plans (see also Appendix B. A Description of the Formal DOD RDT&E System) which are both inputs to and derivatives of the PPBS process, and which also result in the establishment of RDT&E requirements. Military Department requirements are expressed in a number of documents which correspond to various levels of RDT&E activity; the relationship between these statements of requirements is shown in Figure 2. In general, each service divides its requirements between research and operational capability needs.

Since a comprehensive discussion of the requirements formulation process is contained in Appendix B of this report, it is sufficient to note here that policies respecting program initiation, and product development and testing, are initiated periodically by the Secretary of Defense, or Director, Defense Research and Engineering (DDR&E) in formal statements to the Congress or elsewhere in response to the dynamics of both domestic and international affairs. These policy statements impact primarily upon the need to enhance on a priority basis one or more aspects of the U.S. military posture. The policies, directives, or regulations which authorize the development of requirements are only infrequently amended, since these documents are broadly constructed and insensitive to all but major change. The requirements that stem from these general policies, however, are highly vulnerable to modification or cancellation. This is particularly true when major weapons systems are being processed through the development cycle since such diverse reasons as changes in threat, failure to achieve specifications, cost overruns, international agreements



LEGEND: ◇ Documents which provide R&D objectives.

ASOP — Army Strategic Objectives Plan
BASE — Basic Army Strategic Estimate
DPPG — Defense Policy and Planning Guidance Memorandum
JFM — Joint Force Memorandum
JIEP — Joint Intelligence Estimate for Planning
JCREID — Joint Long Range Estimative Intelligence Document
JRDOD — Joint Research and Development Objective Document
JSOP — Joint Strategic Objectives Plan
NLRSS — Navy Long Range Strategic Study
NMRS — Navy Mid Range Study
NMRO — Navy Mid-Range Objectives
POM — Program Objectives Memorandum
PPGM — Planning and Programming Guidance Memorandum

Figure 1 FORMULATION OF R&D OBJECTIVES IN THE PPBS CYCLE

RDTE CATEGORY		APPLICABLE MILITARY DEPT REQMTS DOCUMENT		
		ARMY	NAVY	AIR FORCE
6.1	RESEARCH	OCO AND QCR	NRR, GOR, EDR	RO
6.2	EXPLORATORY DEVELOPMENT	OCO, QRR, QCR AND ROC	EDG, TSOR	RTA AND SCO
6.3	ADVANCED DEVELOPMENT	ROC AND DP	ADO AND TDP	ROC AND PMD
6.4	ENGINEERING DEVELOPMENT	ROC AND DP	SOR AND TDP	ROC AND PMD
6.7	OPERATIONAL SYSTEMS DEVELOPMENT	ROC AND DP	SOR AND TDP	ROC AND PMD
6.5	MANAGEMENT AND SUPPORT	N/A	N/A	N/A

OCO – Operational Capability Objective
QCR – Qualitative Construction Requirement
QRR – Qualitative Research Requirement for Nuclear Weapons Effects Information
ROC – Required Operational Capability
DP – Development Plan
NRR – Naval Research Requirements
GOR – General Operational Requirements (Navy)
RO – Research Objective
SCO – System Concept Options
EDR – Exploratory Development Requirements (Navy)
EDG – Exploratory Development Goals
TSOR – Tentative Specific Operational Requirement (Navy)
ADO – Advanced Development Objective
TDP – Technical Development Plan (Navy)
SOR – Specific Operational Requirement (Navy)
RTA – Required Technology Advance
PMD – Program Management Directive

Figure 2 RELATIONSHIPS BETWEEN MILITARY DEPARTMENT REQUIREMENTS DOCUMENTS

and treaties, and domestic legislation are all potential conduits for program termination.

B. Current RDT&E Activities

The current RDT&E program responds to a complex system of pressures which include formal objectives stated within the PPBS cycle, the requirements of the services, the mandates and preferences of Congress and a multitude of managerial and guidance directors from the Department of Defense.

Modernization is facilitated either by completely replacing obsolete or marginal weapons or by improving the performance of existing systems through the upgrading of subsystems or components. Both approaches are in current use although the present trend of fielding new systems is illustrated by Figure 3, which suggests a shift from the upgrading of weapons (i.e., operational systems development) to a new cycle of replacing outmoded systems.

Figure 4 shows the funding levels by mission area for FY1972 through FY1974 and the budget request for FY1975. As the figure indicates, increased emphasis is being placed on strategic RDT&E although a heretofore stable tactical systems program is also increased in the DOD request. Details of the current RDT&E program together with recent statements of policy and objectives which serve to identify the DOD position and present posture are presented below under the headings of Strategic Force Requirements, General Purpose Force Requirements, and Techhology Base Requirements.

1. Strategic Nuclear Force Requirements

The three RDT&E mission components associated with this category of activity are identified as strategic offensive, strategic defensive, and command, control and communications. Program emphasis is being placed

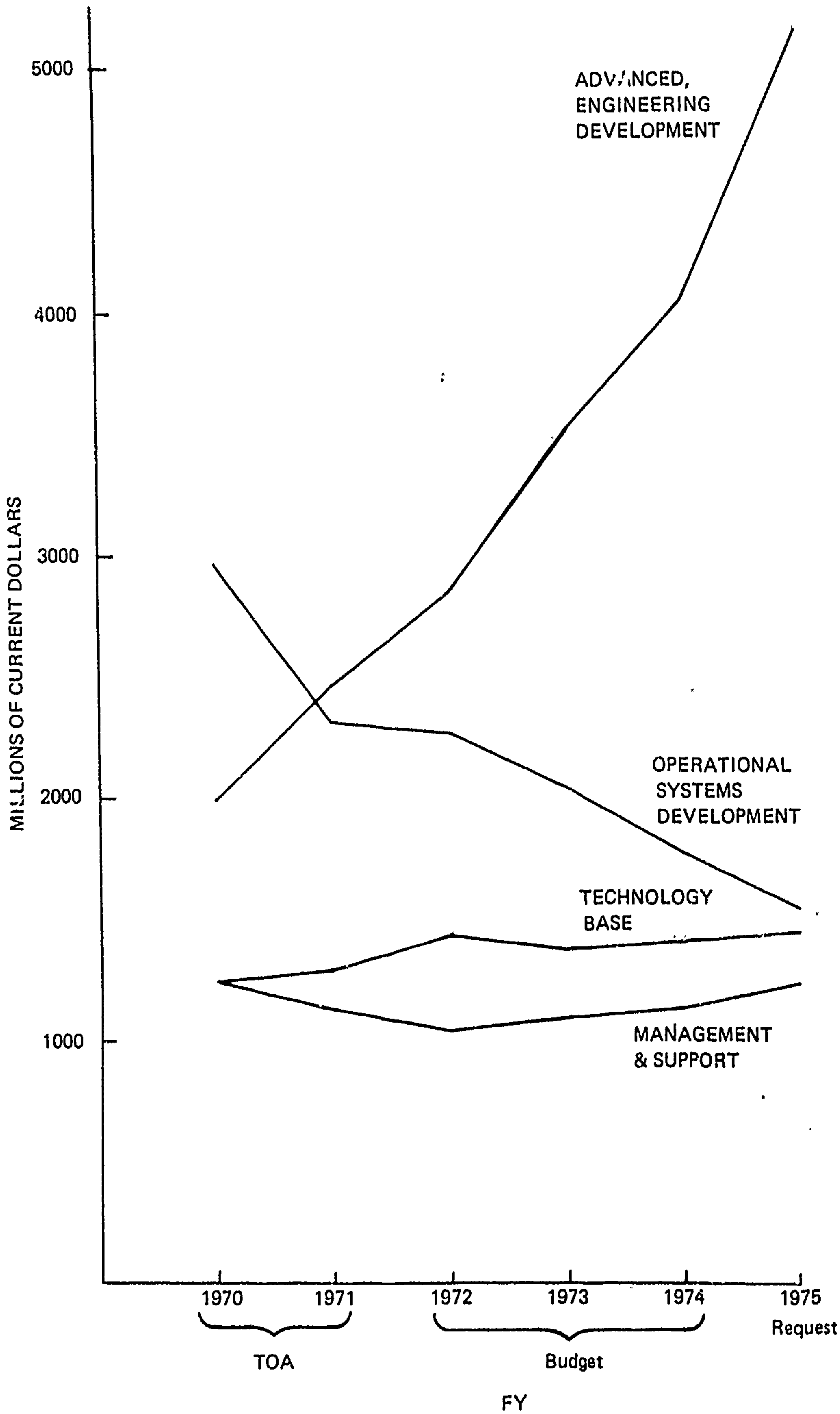


Figure 3 DOD RDT&E DISTRIBUTION BY CATEGORY

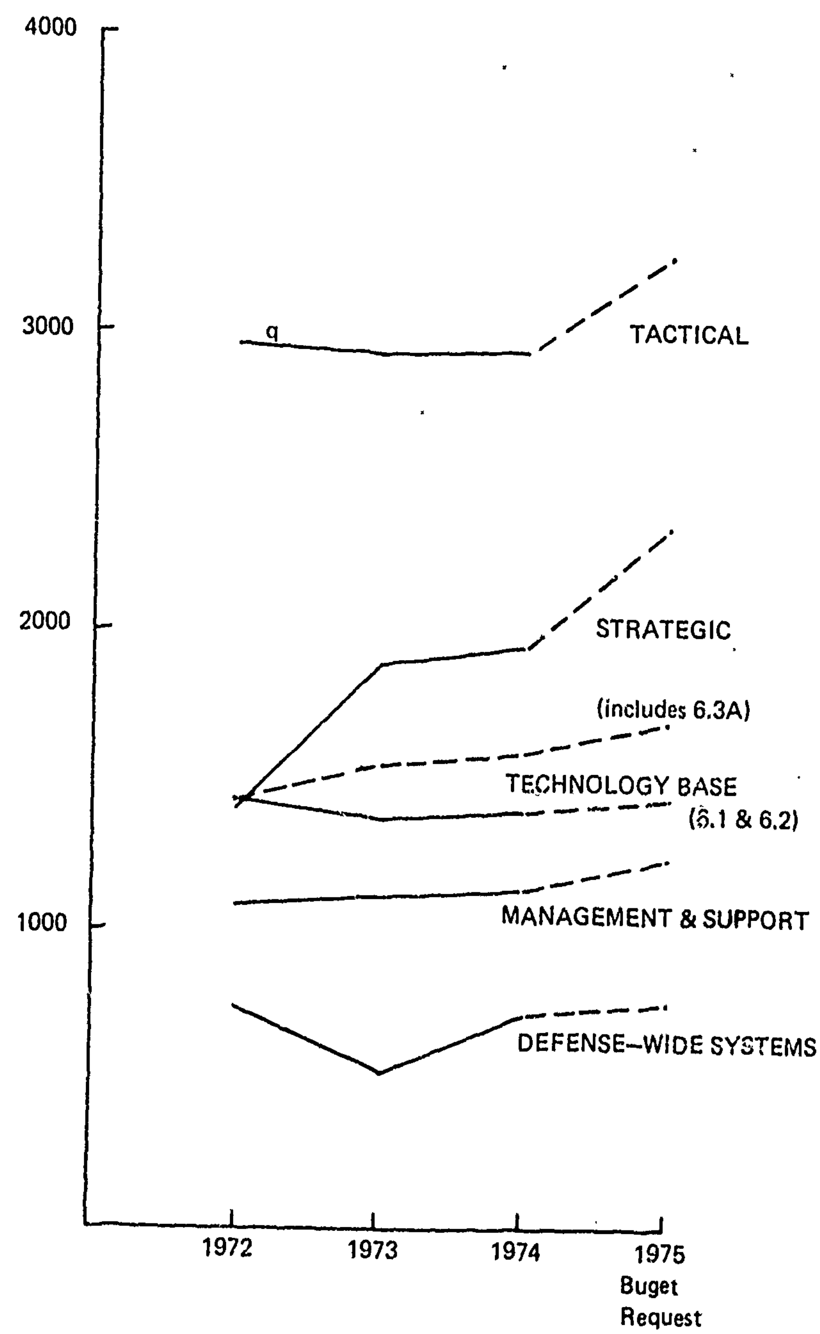


Figure 4 DOD RDT&E BY MISSION

Source: FY 72 -- House Hearings, DOD Appropriations FY 74, p. 476, FY 73 - 75-- Senate Hearings, Military Authorizations Part 3, FY 75, p. 781.

upon the introduction of two new offensive weapons into the inventory, B1 and TRIDENT Missile System), the continuation of strategic defensive efforts (Site Defense and Advanced BMD) as a hedge against SALT failure, the development of a strategic cruise missile (Submarine Launched, Air Launched) to complement the TRIAD, and further RDT&E on improved accuracy and yield for offensive systems (MINUTEMAN and POSEIDON). About 80 percent of the funds requested for strategic RDT&E efforts for FY 1975 are represented in these programs; further details are shown in Table I-1.

In his presentation before Congress supporting the DOD authorization request, Secretary Schlesinger included statements in support of maintaining and improving the U.S. strategic nuclear force. His statement relating to the proposed features of that force is as follows:

> A capability sufficiently large, diversified, and survivable so that it will provide us at all times with high confidence of riding out even a massive surprise attack and of penetrating enemy defenses, and with the ability to withhold an assured destruction reserve for an extended period of time.
>
> Sufficient warning to ensure the survival of our heavy bombers together with the bomb alarm systems and command-control capabilities required by our National Command Authorities to direct the employment of the strategic forces in a controlled, selective, and restrained fashion.
>
> The forces to execute a wide range of options in response to potential actions by an enemy, including a capability for precise attacks on both soft and hard targets, while at the same time minimizing unintended collateral damage.
>
> The avoidance of any combination of forces that could be taken as an effort to acquire the ability to execute a first-strike disarming attack against the USSR.
>
> An offensive capability of such size and composition that all will perceive it as in overall balance with the strategic forces of any potential opponent.
>
> Offensive and defensive capabilities and programs that conform with the provisions of current arms control agreements and at the same time facilitate the conclusion of more permanent treaties to control and, if possible, reduce the main nuclear arsenals.[1]

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[1] Secretary Schlesinger, Hearings Before the Committee on Armed Services, Senate, Fiscal Year 1975 Authorization (5 February 1974), p. 60.

Table I-1

STRATEGIC FORCES PROGRAM
(Proposed FY1975)

		FY1975 Funding Request (Million U.S. $)
• TRIDENT Missile System to replace currently deployed missile submarine		$ 648.8
• B1 Bomber to replace B52		499.0
• Advanced BMD to investigate new technologies for ballistic missile defense		91.4
• Site defense; area ballistic missile defense program in the advanced development phase		160.0
• Alternative basing modes for ICBMs. Investigation of land-mobile and air-mobile alternatives up to the threshold of engineering development for propulsion and guidance technology		37.3
• MINUTEMAN force modernization and improvements		
—Improved accuracy	$32.0	
—Increased yield MK-12	25.0	
—New small RVs for MMITT	19.0	
—Precision measuring system	24.7	
—Other improvements	22.2	142.9
• Initiate advanced development of a terminal guided MARV for ICBM and SLBM utilization		20.0
• ABES. Continued development of vehicle and penetration technology		100.0
• POSEIDON targeting and guidance improvement		33.0
• Prototype development of a strategic subsonic cruise missile		
—Submarine launched		45.0
—Air launched		80.0
• Development of a new class of SSBN, smaller than TRIDENT but slightly larger than the POSEIDON SSBN.		16.0
• Other Strategic Forces Program		505.0
	Total	$2,378.4

The above statement, together with related explanatory data, constitutes the DOD position respecting strategic force needs, supports the FY1975 request for funds, and reflects the defense policies which result in the establishment of RDT&E requirements.

2. General Purpose Force Requirements

There are eight principal missions within the RDT&E spectrum of activities that are associated with General Purpose Forces. These are:

- Tactical Land Warfare
- Air Warfare
- Ocean Control
- Mobility
- Command, Control and Communications
- Intelligence and Reconnaissance
- Special Operations
- Administration

These missions are further subdivided (i.e., air defense, defense suppression, etc.) either to characterize submissions or to conveniently structure the functional activities (i.e., armor, artillery, infantry, etc.) contained within mission descriptions. For purposes of this paper, only principal mission areas will be considered unless major areas of concern or controversy are apparent in the substructure.

Emphasis is currently being placed on the programs of all mission areas. This program attention is in terms of replacing entire systems rather than upgrading older equipment. However, the first four missions noted above continue to absorb the major fraction of RDT&E funds, and are the focal point for the current requirements formulation activity. In accordance with statements to Congress by Dr. Currie, the FY1975 program emphasis for General Purpose Forces is upon:

- Tactical Land Warfare. XM-1 tank, MICV mechanized infantry combat vehicle, AAH advanced attack helicopter, 105mm XM204

and 155mm XM198 artillery, AN/TPQ-37 counter battery radar, TACFIRE tactical fire direction system, SAM-D antiaircraft missile, and STINGER short range antiaircraft missile.

- Tactical Air Warfare. A10, F-15, and F-5F aircraft, CASWS laser guided missile, MGGBTT (Glide Bomb), HARPOON, and CONDOR air-to-surface missile, and RPV remotely piloted vehicle.

- Ocean Control. HARPOON encapsulated antiship missile, SES surface effect ship, AALC amphibious assault landing craft, AEGIS air defense system, and PHALANX antiship missile defense system.

- Mobility. ALH heavy lift helicopter, AMST medium STOC transport, UTTAS tactical transport, VCX carrier delivery transport, and CF-53E amphibious support helicopter.

Table I-2 shows requested FY1975 program funding for these systems as well as for the major continuing programs for the General Purpose Forces.

Dr. Currie in his testimony before the Senate Armed Services Committee on 26 February 1974 made the following comments regarding requirements:

> For the land warfare mission we are required to plan a defense against a force which is markedly superior in surface firepower--armor and artillery. The goal of R&D is to design a force which makes up for this deficiency through superior mobility and weapon precision and to insure that this force is protected against enemy air attack.
>
> Research and development programs for tactical naval forces emphasize improving the fleet offensive capability to counter Soviet stand-off missiles; improving the air defense capability to cope with air, surface and submarine-launched cruise missiles; improving our ability to detect, locate and attack enemy submarines; and improving ocean surface surveillance system to provide the commander more timely intelligence regarding the status of enemy combatants.
>
> R&D to support our tactical air forces is directed primarily toward exploiting recent technology advancements to better transform tactical reconnaissance data into suitable form for use by attack aircraft; improving tactical air command control and communications; modernizing fighter and air-to-air weaponry to provide air superiority; attacking ground targets throughout the battle area by means of standoff systems; and protecting our aircraft against heat-seeking missiles and radar or optically-aimed weapons.

Table I-2

GENERAL PURPOSE FORCES PROGRAM
(Proposed FY1975)

Program		FY1975 Funding Request (Million U.S. $)
Land Warfare Forces		
XM-1 main battle tank		68.8
A-10 aircraft to continue full-scale development		93.9
Advanced Attack Helicopter (AAH)		60.8
SAM-D for medium and high altitude defense to incorporate technological advances in phased-array radars, digital signal processing, and fabrication techniques		111.2
Initiate a U.S. version of a short-range air defense SAM (CROTALE, RAPIER, or ROLAND)		35.0
STINGER portable antiaircraft missile--continuation of engineering development		33.7
Heavy Lift Helicopter (HLH)		57.7
Advanced Medium STOL Transport (AMST)--continued development of prototypes		55.8
Utility Tactical Transport Aircraft System (UTTAS)		54.1
CH-53E helicopter engineering		46.7
Tactical Naval Forces		
HARPOON Antiship (common-launch) Missile--continued engineering development		57.7
Surface-Effect-Ship (SES), 2000 tons--development and testing of smaller prototypes		58.0
Testing of AECIS area defense system		67.0
SM-2 missile--technical and operational evaluation		32.2
Attack submarine improvements		88.5
PHALANX Close-In Weapon System (CIWS)--operational test and evaluation		32.1
Tactical Air Forces		
Advanced Warning and Control System (AWACS)--continued development of the E-3A		219.7
F-15A		182.6
Engine component improvement (CIP)	80.8	
Engine and engine test support	67.6	
Weapons systems, and ground and flight test program	34.2	
Navy low cost fighter-prototype development		34.0

YF 16 and YF 17--20,000 lb aircraft design, fabrication and flight-test	22.7
F401 engine for new aircraft--development	27.5
Navy AGILE air-to-air missile--continue advanced development	20.0
Precision emitter location and strike system--development	25.0
Manned support jammer	36.7
Precision guidance weapons application to conventional weapons--advanced and engineering development	151.4
Remotely Piloted Vehicles (RPV)--major hardware development projects	32.6
PAVE STRIKE programs for precision air-to-ground strikes	40.0
Telecommunications and Command and Control	
Advanced Airborne Command Post (AABNCP) Block I	550.0
Tri-Service Tactical Communications Program (TRI-TAC)	70.6
Other General Purpose Forces Program	888.3
Total	$3,254.3

Source: U.S. Senate, Committee on Armed Services, Hearings on S.3000, Part 3, pp. 792-815 and 905-913 (26-28 February and 4 March 1974).

> Developments in areas that support command and control of our nuclear forces are addressing improvements in survivability commensurate with the change in capabilities of potential enemies that have occurred over the last ten years. In addition, the command and control systems must support new flexible options which have been requested by the President.

The above statements indicate the major thrust of the present RDT&E planning for the General Purpose Forces.

3. Technological Base Requirements

Technological base requirements are governed by and respond to the service documents identified in Figure 2; these are only partially mission oriented and only broadly related to military threats. Because of the cloak of secrecy surrounding all Soviet military research and development, the DOD posture uses this aspect of the R&D program to guard against technological surprise in addition to providing the opportunity for technological breakthrough. To this end, heavy emphasis in policy statements is placed upon the maintenance of a broad technological base with which to guard against adversary breakthroughs in key technological areas. For example, Dr. Foster states:

> Because other national societies are less open than our own, the intelligence we acquire on other countries' technological capabilities and intentions is often delayed. One of the ways we compensate for this time lag is by conducting a vigorous technological program which, by showing us what is--or is not--realistically attainable, enables us to interpret fragmentary intelligence with greater accuracy and insight.[1]

In the late 1960s, "broad" technological superiority was used extensively by DOD representatives in discussions with Congress on the RDT&E program. However, more recent uses of the term have been noted to

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[1] Dr. J. S. Foster, Jr., "The Department of Defense Program of Research, Development, Test and Evaluation, FY1974," statement before the Defense Subcommittee of the Appropriations Committee, U.S. Senate, 93d Congress, 1st Session, pp. 1-11 and 1-12 (28 March 1973).

reflect the need for technological base superiority and selective superiority (rather than broad technological superiority) in the development phase of RDT&E. The situation causing this modification was precipitated by budgetary concerns, selected reliance on allied technological progress, and recognition that the technological base was the appropriate end of the RDT&E spectrum to strive for overall superiority.

The funding for this activity has remained fairly stable in current dollars ranging from 15-17 percent of the total RDT&E budget (see Figure 4). However, these numbers have not been deflated into constant dollars which would show a significant trend downwards in the amount available to attain or maintain superiority.

It is within the basic research and exploratory development categories that successful defense development programs are derived. The devices, techniques, materials and concepts which become building blocks for weapon system development as the drive for technological superiority are derived from these categories. This technology base, which consists of some 20,000 individual programs, is the catalyst for high-payoff technological opportunities.

The technology base is aimed at providing ideas and the capacity for innovation as well as the means to achieve new military capability at lower cost and lesser demands on limited military manpower. In general, it is the nursery of weapon system development and the major stimulant to technology advancement. Some of the subsystem technology opportunities, noted by Dr. Currie in his FY1975 statement, that have emerged from the technology base include precision weapons, space surveillance, and advanced ASW techniques.

Dr. Currie in his Congressional presentation for FY1975 termed the relationship between the technological base and development program as "our long-term security." He further noted:

Successful development programs...and ultimately our continuing security and strength...must derive from the basic exploratory [development] and research which constitutes our defense related technology base. It is this effort that generates from selected fields of science and engineering the devices, techniques, materials and concepts which become building blocks for our developing capabilities.[1]

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[1] Dr. Currie, statement to Congress, Program of Research Development, Test and Evaluation, FY1975.

II FUNCTIONAL DIVISION POLICIES

A. Overview

The functional divisions used in DOD RDT&E are research, exploratory development, advanced development, engineering development, operational systems development, and management and support. The definitions of these functional divisions are given in Table II-1.

Table II-2 shows the varying percentages devoted to each of these categories in recent years (between FY1968 and FY1973) and the budget requests for FY1974 and FY1975. Table II-3 shows the distribution of funds to these categories in millions of constant 1970 dollars for the four-year period, FY1968 through FY1971. These figures show decreases in all of the categories except advanced and engineering development.

There is no formal DOD policy indicating what percentages or funds should be allocated to the six functional categories. Rather these amounts vary according to precedent, opportunities, and needs. They are also subject to budget and congressional constraints.

Table II-4 compares the budget requests for total obligational authority (TOA) with the actual TOA for FY1970 and FY1971. As the table shows, the overall R&D funds were cut almost 10 percent in FY1970 and about 2 percent in FY1971 (based on a more modest request). Further examination of the table indicates the rather severe cuts that were effected--particularly as a percent of funds requested--in FY1970 for research and engineering development.

B. Technology Base

The first two categories, research and exploratory development, plus some fraction of advanced development, are referred to as the technology

Table II-1

DEFINITION OF FUNCTIONAL RESEARCH CATEGORIES

	Definition	Examples
RESEARCH	Includes scientific study and experimentation directed toward increasing knowledge and understanding in those fields of the physical, engineering, environmental, biological-medical, and behavioral-social sciences related to long-term national security needs. It provides fundamental knowledge for the solution of identified military problems. It also provides part of the base for subsequent exploratory and advanced developments in Defense-related technologies and of new or improved military functional capabilities in areas such as communications, detection, tracking, surveillance, propulsion, mobility, guidance and control, navigation, energy conversion, materials and structures, and personnel support.	Research in astronomy, materials, passive night vision, atmospheric sciences, shaped charges, and radiology.
EXPLORATORY DEVELOPMENT	Includes all effort directed toward the solution of specific military problems, short of major development projects. This type of effort may vary from fairly fundamental applied research to quite sophisticated bread-board hardware, study, programming and planning efforts. It would thus include studies, investigations and minor development effort. The dominant characteristic of this category of effort is that it be pointed toward specific military problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions and determining their parameters. Program control of the Exploratory Development element will normally be exercised by general level of effort.	Initial development of boundary-layer-control airfoils, variable suspension for vehicles, turbine engines, and very high-output diesels, inertial-guidance components, and radiological protection.

Table II-1 (Cont'd)

DEFINITION OF FUNCTIONAL RESEARCH CATEGORIES

	Definition	Examples
MANAGEMENT AND SUPPORT	Includes research and development effort directed toward support of installations or operations required for general research and development use. Included would be test ranges, military construction, maintenance support of laboratories, operations and maintenance of test aircraft and ships and studies and analyses in support of the R&D program. Costs of laboratory personnel, either in-house or contract-operated, would be assigned to appropriate projects or as a line item in the Research, Exploratory Development, or Advanced Development programs areas, as appropriate. Military construction costs directly related to a major development program will be included in the appropriate element.	Operation and support of test ranges and operation and support of test aircraft and ships.

Source: DOD Directive No. 7720.16 (Encl 3), (3 September 1970).

Senate Hearings Before the Committee on Appropriations, Department of Defense Appropriations, H.R. 15090, 91st Congress, 1st Session, FY1970, pp 198-199 (June 1969).

Table II-1 (Cont'd)

DEFINITION OF FUNCTIONAL RESEARCH CATEGORIES

	Definition	Examples
ADVANCED DEVELOPMENT	Includes all projects which have moved into the development of hardware for experimental or operational test. It is characterized by line item projects and program control is exercised on a project basis. A further descriptive characteristic lies in the design of such items being directed toward hardware for test or experimentation as opposed to items designed and engineered for eventual Service use.	Development of experimental boundary-layer control aircraft and experimental missile for tanks.
ENGINEERING DEVELOPMENT	Includes those development programs being engineered for Service use but which have not yet been approved for procurement or operation. This area is characterized by major line item projects and program control will be exercised by review of individual projects.	Engineering of an advanced tactical fighter aircraft and engineering of a ballistic missile defense system.
OPERATIONAL SYSTEMS DEVELOPMENT	Includes research and development effort directed toward development, engineering and test of systems, support programs, vehicles and weapons that have been <u>approved for production and Service employment</u>. This area is included for convenience in considering all RDT&E projects. All items in this area are major line item projects which appear as RDT&E Costs of Weapons Systems Elements in other Programs. Program control will thus be exercised by review of the individual research and development effort in each Weapon System Element.	Engineering of an intercontinental ballistic missile system and engineering of a space tracking system.

Table II-2

DEVELOPMENT DISTRIBUTION OF DOD RDT&E
(Percentage)

Functional Research Category	Total Obligational Authority				Budget Authority		Budget Request	
	1968	1969	1970	1971	1972	1973	1974	1975
Research	5.0%	5.2%	4.4%	4.4%	4.3%	3.8%	3.7%	3.3%
Exploratory Development	12.5	11.3	12.3	13.4	14.5	13.4	13.1	12.2
Technology Base	17.5	16.5	16.7	17.8	18.8	17.2	16.8	15.5
Advanced Development	10.0	12.5	12.9	14.6	16.7	16.5	17.7	21.9
Engineering Development	11.1	10.3	14.0	19.6	20.8	27.3	30.7	33.1
Management and Support	15.4	15.8	16.7	15.7	13.8	13.7	13.6	13.1
Operations Systems Development	46.0	44.9	39.7	32.3	29.9	25.3	21.2	16.4
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Sources: Senate Hearings, DOD Appropriations FY1970, p. 197
__________, FY1971, p. 440
__________, FY1972, p. 408
__________, FY1973, p. 646
__________, FY1974, p. 912
Calculated from table presented in:
Dr. M.R. Currie, "The Department of Defense Program of Research Development, Test and Evaluation, FY1975," statement before the Committee on Armed Services of the U.S. Senate, 93rd Congress, 2d Session, 26-27 February 1974, pp. 1-29.

Table II-3

DEVELOPMENT DISTRIBUTION OF DOD RDT&E
(Million Constant 1970 U.S. $)

	1968	1969	1970	1971	Percentage Change 1968-1971
Research	408.2	428.6	324.4	297.5	-27.1
Exploratory Development	1006.7	928.0	920.4	903.9	-10.2
Technology Base	1414.9	1356.6	1244.8	1201.4	-15.1
Advanced Development	809.6	1022.9	960.8	984.2	+21.6
Engineering Development	897.8	848.8	1039.3	1321.4	+47.2
Management and Support	1247.2	1301.0	1245.6	1057.9	-15.2
Operations Systems Development	3719.4	3695.2	2960.6	2167.8	-41.7
Total	8088.9	8224.5	7451.1	6732.7	-16.8

Sources: Senate Hearings, DOD Appropriations FY1970, p. 197
FY1971, p. 440
FY1972, p. 408
FY1973, p. 646
FY1974, p. 912

Table II-4

COMPARISONS OF REQUESTED TOA WITH ACTUAL TOA
(Million U.S. $)

	FY 1970 Requested	FY 1970 Actual	FY 1970 % Difference	FY 1971 Requested	FY 1971 Actual	FY 1971 % Difference
Research	$ 432.3	$ 324.4	-25.0%	$ 369.6	$ 317.6	-14.1%
Exploratory Development	970.5	920.4	- 5.2	897.4	965.2	+ 7.6
Technology base	1,402.8	1,244.8	-11.3	1,267.0	1,282.8	+ 1.2
Advanced Development	1,257.1	960.7	-23.6	1,112.7	1,051.0	- 5.5
Engineering Development	1,083.4	1,039.2	- 4.1	1,395.9	1,411.2	+ 1.1
Management and support	1,262.7	1,245.5	- 1.4	1,167.5	1,129.6	- 3.2
Operational systems development	3,121.4	2,960.7	- 5.1	2,352.5	2,314.9	- 1.6
Emergency fund	100.0		n.a.	50.0		n.a.
Total	$8,227.4	$7,450.9	- 9.4%	$7,345.6	$7,189.5	- 2.1%

Source: Senate Hearings FY70, p. 197
FY71, p. 440
FY72, p. 408
FY73, p. 646

base. This base is purposefully broad and diversified, encompassing all the disciplines within science and engineering. It is executed by the Army, Navy and Air Force, the Defense Nuclear Agency and ARPA. DOD has almost continuously requested increased funds for the technology base because it is the basis for new advanced military systems, and the research in this area brings increased understanding that reduces the possibility of technological surprise. The research resulting from the technological base can also point the way to achieving current military capabilities at lower cost or lessening the demands on military manpower.

In 1974 the technology base was changed to include some projects in advanced development that are directed toward improving methods of dealing with operational needs, rather than culminating in operational systems. (These programs are referred to as Advanced Technology Development (ATD) projects.) The change came about because of the increased emphasis on design-to-cost management which results in reducing technological innovation in engineering and operational systems development. Thus the amount of funds in advanced development for these kinds of research projects would be expected to increase to keep a proper balance. This is reflected in the budget request for FY1975 as shown in Table II-2.

Despite DOD's concern for a technological program to reduce technological surprise, Table II-2 shows that the amount of funds allocated to the technological base, expressed as a percentage of the total, was approximately the same in FY1973 as it was in FY1968. The budget request for FY1975 will actually show a smaller percentage for research and exploratory development than was authorized in FY1973.

Executive Order 10521 guidelines state that, while the National Science Foundation (NSF) shall be increasingly responsible for providing Federal support for general purpose basic research, the conduct and support of basic research in areas which are closely related to their

missions is recognized as important and desirable and shall continue.[1] This policy was emphasized by the Mansfield Amendment to the Military Procurement Act of 1970 that prohibited defense agencies from supporting research unless it is directly relevant to a "service mission." In spite of the Executive Order mentioned above, the NSF has recently been charged with increased responsibilities in the area of applied research, without increased funds, so that their support of basic research is decreasing.

It is DOD policy to coordinate their basic research program with NSF and to encourage the support of basic research by other government and private agencies.[2] Table II-5 shows the percentage of funds expended for basic research by DOD, other government agencies, and industry.

This year, DDR&E and the Service Assistant Secretaries are reviewing the technology base; aggregating the programs into areas of special potential and areas of diminishing returns on investment; and focusing on mission area technological barriers. Until this review is completed, the technology base, as a percentage of the total, will be kept low (and in fact is the lowest in the eight-year period, as shown in Table II-2). The greatly increased request for advanced development funds in FY1975 over FY1974 is the result of a decision to emphasize technical exploration and the development of options that might later be carried into full engineering development.

C. Other Functional Categories

Table II-2 shows that, as a percentage of the total, advanced development has doubled and engineering development tripled in the eight-year period, while operational systems development has decreased dramatically. Table II-3 shows the large increases in TOA in constant dollars between

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[1] DOD Directive 3210, "Administration and Support of Basic Research" (26 October 1961).

[2] Ibid.

FY1968 and FY1971 for advanced and engineering development, and the greatly decreased funding for operations systems development.

Table II-5

R&D
(thousands of dollars)

	1970	%	1971	%	1972	%
Total Federal	15,329,816		15,549,506		16,552,649	
Basic	2,062,256		2,102,348		2,410,849	
Applied	3,539,650		4,017,859		4,168,229	
B&A	5,601,906		6,150,207		6,579,078	
Total DOD	7,360,368		7,509,036		8,318,145	
Basic	246,670	03	261,545	03	270,336	03
Applied	1,310,113	18	1,351,410	18	1,493,340	18
B&A	1,556,783	21	1,612,955	21	1,763,676	21
Industry	10,434,000		10,817,000		11,427,000	
Basic	536,000	05	565,000	05	576,000	05
Applied	2,406,000	23	2,475,000	23	2,553,000	22
B&A	2,942,000	28	3,040,000	28	3,129,000	27
Total Federal-DOD	7,969,448		8,040,470		8,234,504	
Basic	1,815,586	23	1,870,803	23	2,140,513	26
Applied	2,229,537	28	2,666,449	33	2,674,889	32
B&A	4,045,123	51	4,537,252	56	4,815,402	58

Source: NSF Federal Funds NSF 71-35, Table C-4; NSF 72-317, Table C-4; Volume XXII, Appendixes C&D, Table C-4, 5, and 6; NSF National Patterns of R&D Resources 1953-1974, Tables B-4, 5, and 6 per telecon with NSF Industry Studies.

III COOPERATIVE POLICIES

A. U.S. and Allies

Cooperation between the United States and its allies in military R&D, for all practical purposes, began in 1954 with the establishment of the Mutual Weapons Development Program (MWDP). As a result, multinational technical centers to support NATO, technical data exchange programs, and multinational R&D programs were established.

On 25 October 1957 the President of the United States and the Prime Minister of Great Britain made a Declaration of Common Purpose which contained some of the concepts of the later Nixon doctrine:

> The arrangements which the nations of the free world have made for collective defence and mutual help are based on the recognition that the concept of national self-sufficiency is now out of date. The countries of the free world are inter-dependent and only in genuine partnership, by combining their resources and sharing tasks in many fields, can progress and safety be found. For our part we have agreed that our two countries will henceforth act in accordance with this principle. [Emphasis added by the author of this report]

Immediately afterwards, the Canadian Government subscribed to this principle of interdependence and joined in the common effort. The resulting organization, called the Tripartite Technical Cooperation Program (TTCP), was the basis for the Technical Cooperation Program formed in 1965. This program is discussed, in some detail, below.

In 1963, the MWDP was expanded to the Mutual Weapons Development Data Exchange Program (MWDDEP) with the objective of better coordinating the technological capabilities of the United States and its allies, reducing the costs and duplication of development efforts, and advancing the concept of standardization. At the same time, the Defense Development Exchange

Program (DDEP) was established to cooperate with U.S. allies in the Far East. Its objectives were similar to those of the MWDDEP.

DOD Directive 3100-3 (also issued in 1963) established policy regarding U.S. cooperation with allies in R&D.[1] The policy stated that "the U.S. will cooperate with its Allies to the greatest degree possible in the development of defense equipment, where such cooperation is in the overall best interests of the United States." To this end, DOD was directed to:

1. Continue to encourage the mutual development of technical capabilities, in particular through exchanges of significant information.

2. Coordinate exploratory, advanced and engineering development plans to minimize wasteful duplication.

3. Participate in joint development programs for major systems meeting harmonized requirements, whenever such programs meet the objectives and criteria listed in this directive.

4. Consistent with OSD guidance, consider promising foreign as well as U.S. R&D resources prior to placing research and development contracts.

5. Facilitate availability of U.S. R&D resources to foreign procurement agencies, on terms similar to those governing availability of these resources to U.S. agencies.

The DOD Directive was supplemented by Army, Navy, and Air Force regulations that specified ways and means to implement their cooperative policies.[2] In addition, DOD Directive No. 3110.4, also issued in 1963, stated that it was the policy of the United States to actively seek to harmonize its military

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[1] DOD Directive No. 3100-3, "Cooperation with Allies in Research and Development of Defense Equipment" (27 September 1963).

[2] Army Regulation No. 70, "Cooperation with Allies in Research and Development of Defense Equipment" (13 December 1963); Department of the Navy SECNAV Instruction 300-2, "Cooperation with Allies in Research and Development of Defense Equipment" (12 October 1963); and Air Force Regulation No. 80-21, "Cooperation with Other Countries in Research and Development of Defense Equipment" (27 January 1964).

requirements with those of its allies to facilitate the goal of increased cooperation in R&D. This includes allies adjusting differences or inconsistencies in materiel requirements. This requires cooperation among allies, starting with the establishment of tactical concepts and continuing through the steps of requirements formulation.[1]

In May 1966 the North Atlantic Council revised the NATO organization and procedures to improve its ability as a discussion forum and clearing house instituting cooperative projects. A conference of National Armaments Directors was established to deal with the development and procurement of equipment for NATO forces. Army, Navy, and Air Force Armaments Groups and a Defense Research Group were established as the action bodies to initiate cooperative efforts. DDR&E arranges for U.S. representation at the meetings of the Conference.[2]

In spite of these policies, cooperation has not developed as much as might be hoped for, and it has been estimated that over $1 billion worth of Allied efforts duplicate to some extent that of the United States.[3] Part of the duplication has been caused by national desires to support national industries, expand their national technological base, support a growing economy and develop systems to meet varying national needs. In fact, in the FY1974 Senate Appropriations Hearings, Secretary Richardson testified that the duplication had been increasing and DOD had been attempting to find ways to reduce the excess duplication in tactical weapons development. In 1969 the United States established an R&D group composed of the United States, the United Kingdom, France, and West Germany to find ways to decrease this duplication.

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[1] Source: DOD Directive 3100.4, "Harmonization of Qualitative Requirements for Defense Equipment of the United States and its Allies," 27 September 1963.

[2] DOD Directive 5100,53, "U.S. Participation in Certain NATO Groups Relating to the Research Development Production and Logistics Support of Military Equipment" (29 July 1967).

[3] Senate Hearings, DOD Appropriations FY1973, p. 610.

By 1972 the principal treaty organizations for sharing R&D were the Technical Cooperation Program (with the U.K., Canada, Australia, and New Zealand) and several science and technology organizations within NATO. The Technical Cooperation Program's major emphasis is in the technology base. This program is a vehicle not only for exchanging information but also for reviewing each other's programs, recommending new directions or cooperative programs, and exchanging materials, equipment, and test items.[1] It also serves as a vehicle to establish bilateral or multilateral agreements among countries.[2] The United States is now exchanging information on key requirements, capabilities, and decision dates relating to national developments on a regular basis with NATO allies. The implementation status of some of these policies is discussed below.

Although the United States is working with Italy and Germany on the NATO hydrofoil program, the coordination of development programs appears to be one of the weaker areas of cooperation listed above.

In 1973, Dr. Currie stated that he did not believe in joint programs, and mentioned the bad experience with MBT-70 as an example.[3] He does, however, favor the United States manufacturing allied defense systems that meet U.S. needs. When this occurs, U.S. policy is that any hardware developed by the Allies that is selected for U.S. forces will be produced in the United States under license. This is to provide employment for U.S. workers and establish a production base in the United States.

Recently, procedures were instituted that make it mandatory for the United States to consider foreign alternative defense systems at key

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1 "The Technical Cooperation Program: Policies, Organization and Procedures in Non-Atomic Military Research and Development," Washington Secretariat (April 1973).

2 DOD Directive No. 3100.8, "The Technical Cooperation Program," 11 September 1973, p. 2.

3 House Hearings, DOD Appropriations, FY1974, p. 510.

DSARC milestones.[1] Secretary Richardson stated that the policy of depending on Allies for tactical weapons systems is a departure from past U.S. practices.[2] Allied systems that have been utilized by the United States include RATAC, a long-range ground radar developed by France and Germany, and the U.K. carrier aircraft. Other systems are being tested for possible U.S. use.

The following paragraphs discuss the resources (budgetary, manpower, organizational, etc.) that are allocated in support of cooperative policy and the degree of consistency and emphasis given this policy. Although tracking down the allocations to cooperative support would require a study of considerable magnitude, the description that follows at least generalizes its approximate size and shape.

Dr. Currie, the DDR&E, is the primary representative on all major international technical bodies. Each service also has a principal R&D representative. As the technologies are divided into specific areas, subgroups and panels are formed. Production and logistics are considered within these same organizations--a factor which makes RDT&E cooperation more difficult to isolate.

As most of the cooperative effort is with NATO, its principal cooperative organizations are described first.

The Defense Department has the following representatives involved in a basic and formal organization of international technological cooperation with NATO.

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1 Senate Hearings, DOD Appropriations FY1974, p. 503.

2 Senate Authorization Hearings for FY1974, Committee on Armed Services, Part 1, p. 323.

DDR&E, Deputy Director (Tactical Warfare Programs)
Assistant Director (International Programs)

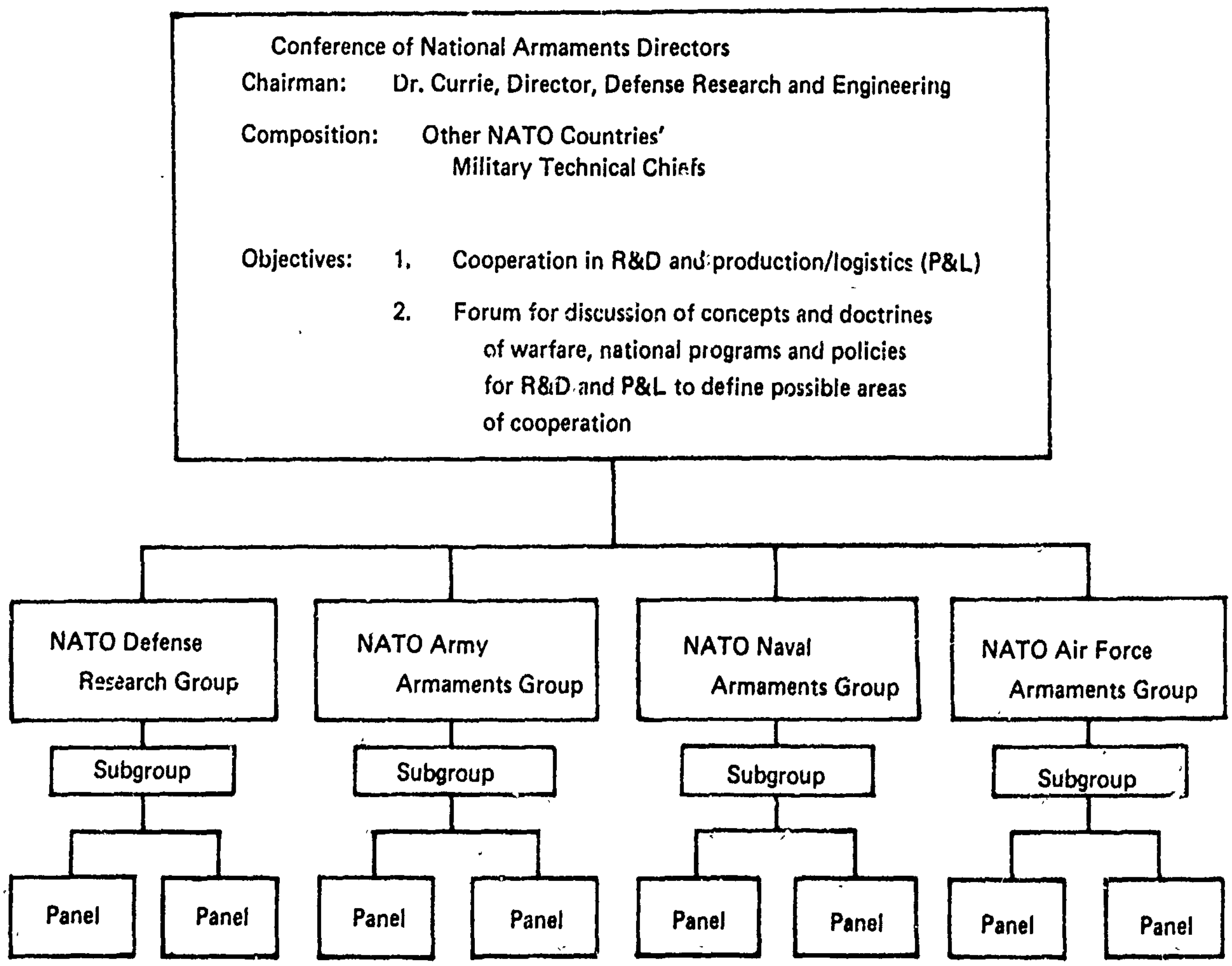
U.S. Army, Office of the Chief of Research & Development (OCRD) International Division

U.S. Air Force, Deputy Chief of Staff Research and Development
Directorate of Development and Acquisition
Science and Technology Division

U.S. Navy, Director, Tactical Air Surface and Electronic Warfare Development Division of the Office of Research, Development, Test and Evaluation

The formal NATO organization has a basic framework as shown in the figure below:

NATO TECHNICAL ORGANIZATION



Within each service, technicians and scientists are drawn upon as required to fulfill the requirements in this NATO organization. For example, the Army participates in 30 subgroups requiring 3 people per group to attend meetings and 10 to 12 to participate in preparations. Additionally, the participants are drawn from the appropriate laboratories or from other scientific organizations throughout the Army Materiel Command (AMC). The Air Force and Navy similarly draw upon experts from their research and technical organizations. Two specific arrangements frustrate attempts to track money and/or manpower. First, the project officer and his team members, who are responsible for the cooperative efforts, do this on a part-time "as required" basis. Second, laboratory and other scientific echnical representatives who attend are charged against their basic nizational area accounts, e.g., electronics, ASW. Therefore, total expenditures and total manpower are virtually impossible to derive.

For each service there are three budget lines used for cooperative activities. The first is the travel allocation (e.g., $300K for the Air Force, $400K for the Army). The second is for scientists maintained abroad (e.g., $750K for 12 scientists maintained in the SHAPE technical center by the Air Force and a proportionate amount for 9 scientists maintained by the Navy in the SACLANT ASW technical center). The third is for RDT&E associated with specific sharing of projects with foreign countries or testing foreign weapon systems in anticipation of buying them. The mutual costs are worked out in terms of who pays and the duration of the project. Then fiscal support is requested and reflected as a line item in the budget.

Research exchange in addition to NATO consists of the Technical Cooperation Program (TTCP) that involves the United States, Great Britain, Canada, Australia, and New Zealand, and approximately 180 bilateral agreements. The Technical Cooperation Program also calls for subgroups and panels with ad hoc participants, depending on the subjects and the extent of expertise required. Again the manpower and expenditure are virtually impossible to track.

The research exchange involves basic research through the RDT&E associated with operational testing. The efforts and expenditures are not consistent in all respects. Although the travel and foreign assignment costs remain about the same, the third item, specific weapon system or research project cooperation, can vary considerably from year to year. This year, for example, the Air Force and Army have no funds budgeted for this purpose.

The ongoing international cooperative research and development programs as of 30 September 1973 are shown in Table III-1.

B. Adversaries

In the May 1972 "Moscow Basic Principles of Relations," Article 8 stated:

> The two sides consider it timely and useful to develop mutual contacts and cooperation in the fields of science and technology. Where suitable, the USA and the USSR will conclude appropriate agreements dealing with concrete cooperation in these fields.[1]

U.S. industry went into action almost immediately in trying to promote sales of technology and products to the USSR. In a December 1973 speech, Dr. Currie expressed his concern over the resulting tendencies and trends:

> My concern is this: it often requires many years to translate research demonstrations into viable manufacturing technologies which incorporate the elements of high productivity and quality control. I think that we sometimes fail to appreciate, from our perspective, the difficult and long gap between science and manufacturing technology. But I can assure you that the rest of the world and our potential adversaries, in particular, do not. Under competitive pressure and in the face of an opportunity for a short-term gain--which in itself might be an illusion--

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[1] Moscow: "Basic Principles of Relations," Article 8, p. 2 (29 May 1972).

Table III-1

ONGOING INTERNATIONAL COOPERATIVE RESEARCH AND DEVELOPMENT PROGRAMS

SEPTEMBER 30, 1973

Program title	Effective starting date	Estimated completion date	Foreign participants	Military service	U.S. share of research and development costs: Amount	Percent
Engineering development:						
NATO hydrofoil fast patrol ship (note a)	(b)	June 1975	Federal Republic of Germany, Italy	Navy	$75,900,000	71.0
NATO Seasparrow surface missile system (note a)	June 1968	Feb. 1976	Belgium, the Netherlands, Italy, Norway, Denmark	Navy	29,314,000	63.6
Side-looking airborne radar improvement program (note c)	Dec. 1968	Jan. 1974	Federal Republic of Germany	Air Force	11,[illegible]0,000	50.0
Band IV headset for GRC-130 radio relay set (note a)	Mar. 1971	Feb. 1979	Canada	Army	[d]1,500,000	[d]50.0
Meteorological research, development, test, and evaluation rocket vehicle and associated equipment	Aug. 1966	June 1974	Canada	Army	1,109,387	42.4
Advanced development:						
Reliable acoustic path sonar	Mar. 1972	Mar. 1977	France	Navy	(e)	[d]20.0
Planar array sonar	Sept. 1968	Jan. 1976	United Kingdom	Navy	(e)	[d]25.0
Polar cap III (note f)	Mar. 1972	Dec. 1974	Canada	Air Force	[d]5,000,000	[d]89.0
Javelot weapon system	Apr. 1971	Apr. 1976	France	Army	1,351,000	50.0
Aircraft air-cushion landing system	May 1971	Nov. 1975	Canada	Air Force	6,900,000	55.2
Tactical aircraft guidance system	Dec. 1968	Jan. 1974	Canada	Army	14,070,000	60.0
Recording radiation monitor and automatic radiation alarm system	Dec. 1971	May 1977	Canada	Army	[d]225,000	[d]50.0
Individual (personal) radiation dosimeter and reader	May 1973	May 1975	United Kingdom	Army	300,000	50.0
Exploratory development:						
Plasma research	Sept. 1966	June 1974	Italy	Air Force	179,000	31.0
Analytic photogrammetry	Feb. 1965	Continuing	Italy	Air Force	221,700	60.0
Gas and aerosol cloud diffusion studies	Aug. 1967	Jan. 1974	Norway	Army	100,000	39.0
Fuel cell research	Nov. 1968	Nov. 1974	United Kingdom	Army	640,000	63.0
Chemical agent alarms	Mar. 1971	July 1974	United Kingdom	Army	(g)	-
Lightweight steel armor and aluminum alloy	July 1971	Sept. 1974	United Kingdom	Army	[h]27 man-years	50.0
Fragmenting mechanisms in naturally fragmenting materials	July 1971	July 1974	Australia	Army	[h]6 man-years	50.0
Basic research:						
Deep diving research	Oct. 1970	Continuing	United Kingdom	Navy	(i)	(i)
Shallow-water acoustic research	June 1972	Continuing	The Netherlands, Federal Republic of Germany	Navy	(h)	(h)
Aluminum alloy research	July 1968	Dec. 1975	Italy	Army	458,333	59.0
Improved photochromic materials	June 1971	Sept. 1974	Greece	Army	[h]3 man-years	50.0
Helicopter dynamics	Dec. 1971	Dec. 1974	France	Army	[e,h]12 man-years	50.0
Transient radiation effects on electronics as relating to leopard tank	Aug. 1971	Jan. 1975	Federal Republic of Germany	Army	(j)	(j)
Room temperature injection luminescence in wide band gap semiconductors	Dec. 19[illegible]1	Mar. 1974	Canada	Air Force	70,000	50.0
Other:						
Thrust-measuring system (note k)	Fiscal year 1970	June 1974	Canada	Air Force	504,500	50.0
Azores fixed acoustics range (note l)	June 1968	Continuing	France, Italy, Canada, Federal Republic of Germany, United Kingdom, the Netherlands, Portugal	Navy	2,000,000	67.0

[a]The program agreement provides for follow-on coproduction.

[b]Contracts were awarded in November 1971. Italy, Germany, and the United States signed the Memorandum of Understanding on November 23, 1972.

[c]The United States is doing all the work and the Federal Republic of Germany is providing 50 percent of the funding.

[d]Estimated by responsible service official.

[e]Individual funding levels are classified; however, total U.S. share for both programs amounts to approximately $20.2 million.

[f]The United States-Canadian Defense Development Sharing Program, which is explained on page 17, does not include this program.

[g]Program work is being done by the United Kingdom; the United States is furnishing data and components.

[h]Work was divided equally between participants with each participating country funding its respective effort. U.S. costs could not be determined because the programs are tasks of larger programs. Likewise, budgets costs are buried within broader program elements appearing in military budgets.

[i]Indeterminable, since there is no separate budget line item for this project. Program documentation did not reveal the extent of U.S. funding.

[j]Project office officials stated the Federal Republic of Germany was providing total funding for the program and all work was being done in the United States.

[k]This program involves component improvement.

[l]Program does not involve development of hardware. The project consists of two phases: Constructing the range and conducting experiments using RDT&E funds.

Benefits and Drawbacks of U.S. participation in Military Cooperative Research and Development Programs with Allied Countries. Comptroller General of the United States.

it is possible for a company to give away overnight something which it has spent years of difficult effort to obtain. This is especially true in many high-technology areas which affect our national security as well as our position in world trade.[1]

He then pointed out science and technology areas that would be exploitable under the May 1972 agreement of cooperation in these fields with little or no national security implications. These were energy, disease, and space exploitation for peaceful purposes. Agricultural activities and global fishing problems are two more that can be included.

Dr. Currie's key point in examining the dangers of R&D sales to the Soviets was that their greatest deficiency is production rather than scientific knowledge. Manufacturing technology for integrated circuits, software, aircraft, engines, avionics, and specialized instruments is particularly critical in preserving U.S. national security. The Soviets are approaching the problem by procuring or attempting to procure complete turn-key plant operations in the critical areas. With the U.S. eagerness to reverse the deficit trade balance, the United States could give away significant technological capabilities for the pie-in-the-sky of future markets with the Soviets.

DOD has review authority over proposed trades and military implications, but there are many marginal areas. The turndown of a deal that has been publicly negotiated and affects balance of trade is a difficult political decision. The United States is in a unique situation. Both France and England deal government-to-government with the Soviet Union, but the United States maintains a hands-off policy until it is time to review the proposed sales of products or R&D to the Soviet Union.

The following examples of U.S.-Soviet contractual ties illustrate the situations whereby the Soviets would very quickly acquire expertise that took the United States many years to develop:

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1 Dr. M. R. Currie, Director, speech before the NSIA Symposium on R&D, Washington, D.C. (5-6 December 1973).

a. Lockheed Aircraft and the Russians have agreed to conduct joint research on airplanes and helicopters and in other areas.[1]

b. Kaiser Industries will discuss the exchange of know-how with the USSR in such fields as mining, metal production and port construction.[1]

c. American Can and Armco Steel have agreed to swap technical know-how with Soviet agencies.[2]

d. IBM and Univac (Sperry Rand) are competing for contracts in data processing setups for civilian air traffic control and a passenger reservations system for Aeroflot. Both of these contracts would require clearance from DOD because of the military applications. These two system solicitations are viewed as part of a Soviet drive to draw on U.S. computer capability in an effort to catch the West in this area. Other evidence of this was seen in the October 1973 10-year contract between the Soviets and Control Data Corporation to develop the national planning system of the USSR.[3]

e. Occidental Petroleum will build eight liquid ammonia plants and two urea plants in Russia at a total cost of $500 million.[4]

f. The Soviets contracted for an IBM 370 computer system for Intourist, the USSR travel agency, at a total price of $10 million.[5]

g. Control Data Corporation and the Rumanian Government formed a joint campaign in Rumania to make computer peripheral equipment.[6]

h. Swindell-Dressler has designed a foundry for the Russians on the Kama River for $10 million. The foundry will produce 250,000 engine blocks per year, and the plant will require $190 million worth of equipment. Swindell is also furnishing $16 million worth of arc furnaces.[7]

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[1] U.S. News and World Report, p. 90 (25 February 1974).

[2] Ibid., p. 42 (7 January 1974).

[3] Ibid., p. 77 (28 January 1974).

[4] Business Week, p. 34 (19 May 1972).

[5] Ibid., p. 58 (28 April 1973).

[6] Ibid., p. 39 (7 April 1973).

[7] Ibid., p. 40 (17 March 1973).

i. The Reda Pump Division of TRW will provide $25.9 million worth of submersible oil pumps to the Soviets.[1]

j. IBM and Raytheon have submitted bids in the $60-80 million range to provide the Soviets with an automated air traffic control system.[2]

k. Boeing, McDonald-Douglas and Lockheed are negotiating with the Soviets to provide them technological assistance in building an aviation complex employing 80,000 people to build jet aircraft.

A National Trade Council for U.S.-China trade was set up by the government in early 1973; the first meeting was held on 31 May 1973.[3] Sales to China were expected to be large in the areas of jet transports,[4] communications equipment and grain. Subsequent major sales were estimated for oil refineries, mining machinery, and transportation equipment.[5] Contrasted with the Soviet effort to buy R&D technology, the Chinese are concentrating on relatively basic needs. For the immediate future, the trade with China will not give DOD nearly as many difficult decisions as that with the USSR and other Warsaw Pact countries.

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1 Ibid., p. 21 (5 March 1973).

2 Aviation Week and Space Technology, p. 30 (21 January 1974).

3 Ibid., p. 42 (7 January 1974).

4 Business Week, p. 37 (26 May 1973).

5 Boeing had sold China ten 707s plus spare parts for $125 million as of April 1973.

IV PROGRAM IMPLEMENTATION POLICIES

The broad policy and approach to programs was best described by Dr. John S. Foster in 1969:[1]

> In general, the key to sound defense research and development is deceptively simple: our objective on each program and the way we choose to manage it must be clearly and explicitly stated and then fully debated, especially on the largest programs. We must assess deliberately the threat we face, the national goals, the urgency of the solution, the status of the concept and technology, the capabilities of industry, the options available, the costs, and the competing national priorities.

A. Leadtime/Readiness

Dr. Malcolm R. Currie, DDR&E, recently addressed the leadtime and readiness problems in terms of "viable options":[2]

> Our basic research and development strategy is to develop viable options. We must avoid two unacceptable alternatives--either to fully develop and deploy all systems that might be needed or to wait until the adversaries show new capabilities and then develop counter from scratch. A better strategy is to concentrate on generating optional solutions to anticipate problems in the exploratory and advanced development programs but make an explicit decision on need before full engineering development is approved. After advanced development, the technology is certain, but the clear military need may not be. At that point we will proceed with some options, delay others and terminate a good many. If we have the managerial strength to follow through this selection process, the strategy of viable research and development options will provide better deployed systems and flexibility to respond rapidly to change.

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[1] Dr. J.S. Foster, Jr., "The Defense Research and Technology Base," *Defense Industry Bulletin,* p. 11 (July 1969). (Hereafter referred to as Foster, "The Defense Research and Technology Base").

[2] Dr. M.R. Currie, "The Department of Defense Program of Research, Development, Test and Evaluation, FY1975," statement before the Committee on Armed Services of the U.S. Senate, 93d Congress, 2d Session, pp. 1-29 (26-27 February 1974). (Hereafter referred to as Currie, "DOD RDT&E FY1975 Program").

In effect, Dr. Currie is saying that neither maximum procrastination nor full readiness are acceptable solutions. He proposes intermediate readiness to reduce response times in terms of "solutions to anticipated problems in the exploratory and advanced development programs" which are to be followed by explicit decisions for further development if required. Thus the leadtime/readiness policy for RDT&E is quite clear.

B. Technological Uncertainty/Development Risk

1. Type of Contract and Cost Risks

The 1950s were characterized by a trend toward increased use of negotiated and cost-reimbursement contracts" for R&D work. Studies during the late 1950s and early 1960s concluded that cost-type contracts lacked necessary controls and motivation to keep costs down. Recommended were incentive-type cost reimbursement and fixed price contracts. Cost reimbursement incentive contracts provide for cost reimbursement as indicated, but the *fee* is adjusted up or down depending on the contractor's achievements in cost, performance and schedule. Fixed price contracts carried increased or decreased fees within the fixed ceiling and a loss to the contractor could result.

In the 1960s McNamara initiated total package procurement which joined development and initial production work to reduce the likelihood of competing contractors "buying in" during the development phase in order to get leverage for the more lucrative production contract. Significant follow-ons to this concept were the incentive and fixed price contracts which were designed to shift the risk of unexpected costs to the contractor to the fullest extent possible. By the early 1970s the pendulum was swinging back and the government was assuming more risk through cost-type contracting for development. The "fly-before-buy" concept is currently the contracting philosophy. Schedule milestones and project completion are now less important than satisfaction of technical requirements at each milestone and adherence to cost. The Commission Report[1] expressed the latest view of the formerly sacred adherence to performance and schedules.

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[1] Report of the Commission on Government Procurement, Volume 2, "Acquisition of R&D and Major Systems," p. 121, Washington, D.C.: U.S. Government Printing Office (December 1972)

> ...Because performance and schedules have been treated as imperatives, later technical activity has been directed more at making sure the requirements were met than at making changes in response to new information or later assessments of need.

DOD Directive 5000-1[1] has not taken up the problem of single source or parallel development even though the "fly-before-buy" and competitive development is stressed elsewhere--particularly in speeches. The coverage of this directive on risk and type of contract follows below:

> 5. Technical uncertainty shall be continually assessed. Progressive commitments of resources which incur program risk will be made only when confidence in program outcome is sufficiently high to warrant going ahead. Models, mock-ups and system hardware will be used to the greatest possible extent to increase confidence levels.
>
> 7. Contract type shall be consistent with all program characteristics including risk. It is not possible to determine the precise production cost of a new complex defense system before it is developed; therefore, such systems will not be procured using the total package procurement concept for production options that are contractually priced in the development contract. Cost type prime and subcontracts are preferred where substantial development effort is involved. ...When risk is reduced to the extent that realistic pricing can occur, fixed-price type contracts should be issued.

2. Single Source

It has been said that all of the initiative and innovation capabilities of the contractor are exhausted in his preparation of the proposal. In the execution of the contract he then will adhere to the minimal requirements and perform with as little risk as possible. However, in the face of continuing competition, the contractor will continue demonstrating both initiative and innovative techniques as long as competition continues. For these and other reasons, the free enterprise system encourages competition.

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1 Department of Defense Directive Number 5000-1, "Acquisition of Major Defense Systems," p. 5 (13 July 1971).

Everything possible has been done to insure competitive bidding either through open bidding or negotiation with qualified contractors in the provisions of the Armed Services Procurement Regulation (ASPR). Most of the provisions have been included at the instigation of Congress rather than by the Services. In many instances the Services would prefer to pick the contractor who, in their minds, is the best qualified to do the work. The procurement process does not necessarily lead to the selection of the best qualified.

Proposed innovative research would seem a natural candidate for submission to DOD (and other departments of the government) as an "unsolicited proposal". Such a proposal gives the proposer "sole source" privileges of performing what he proposes if the proposal is accepted and funded. Most of the think tank organizations operate on the basis of unsolicited proposals. However, unsolicited proposals are generally not the types that occur in the acquisition of major weapon systems. The Commission Report gives two of the reasons:

> ...companies are reluctant to use this unsolicited proposal route for truly innovative approaches because these ideas will find their way into competitive solicitation (request for proposals--RFP) sent to industry if they are adopted by an agency system design group. Moreover, if a contract is awarded sole source, a company must share the cost of the development effort.
>
> ...If further work is encouraged, it normally is covered through partial reimbursement of charges to overhead expenses.

3. Parallel (Competitive) Development--The Prototype Approach

The current approach to technological uncertainty and development risk is competitive development and test--essentially prototyping. This approach of the 1920s, 30s and 40s was reinstituted by Deputy Secretary of Defense Packard and Dr. John S. Foster, Jr. about 1969. The impact has been, and apparently will continue to be, (1) to reduce the number of pre-hardware paper studies and (2) to eliminate concurrent development and preparation for production of a new system. Two significantly different procurement management policies which tend to reinforce this prototyping approach are (1): the consideration of trade-offs involving performance

within primary requirements, if necessary, and certainly secondary requirements with related savings to maintain cost control and (2) a lessening of a rigid timetable in development and production in favor of a policy of the achievement of technological program objectives as the pacing function. The combination of these changes should result in a much more flexible, manageable and more satisfying system for both the contractor and the government.

The following paragraphs and quotations amplify and explain the prototype procurement system and the need for it:

> There are many approaches to acquiring weapons. We can concurrently develop the system in the laboratory and prepare to produce it. We can develop prototypes first so that we can "fly-before-buying." Or, we can buy items that have been developed at the supplier's risk and are on the shelf.[1]

This statement covers the gamut from maximum risk, middle-of-the-road approach and the no-risk approach. Although not clear in this statement, prototyping generally means to run parallel development through to completed systems followed by a competitive test ("flyoff") to select the best of two (or more) systems. The phrase "competitive development and test" is an excellent descriptor. Further comments by Dr. Foster bring out the competitive aspects:

> ...In some cases it is essential that we reduce critical subassemblies or components to hardware, often on a competitive basis, in order to gain adequate assurance of feasibility and design stability. Where the system integration is itself a major source of risk, complete prototypes may be mandatory. Where development costs are small in comparison with acquisition and operating costs, the added costs of competition in hardware may well pay off in total economy. In general, where the total research and development cost represents only a few percent of the total systems cost, competitive prototyping is wise; and we will continue to follow this practice, perhaps in more situations.[2]

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1 Dr. J.S. Foster, Jr., Statement of FY1970 Defense RDT&E Program to House Committee on the Armed Services, excerpted in the *Defense Industry Bulletin*, Vol. 5, No. 7 (July 1969).

2 Ibid.

Deputy Secretary of Defense Packard pointed out two practices "which have consistently led to excessive costs and unsatisfactory results in the development and procurement of weapons systems," and then went on to define and distinguish between kinds of prototypes:

> One [problem] is the excessive reliance on paper studies and paper analysis...The other problem is the concurrency between development and production--simply that development has not been sufficiently complete before production is started.
>
> I want to distinguish between the several kinds of prototypes. The first is the advanced development prototype, where a proposed new weapon would be designed, built, and tested to confirm that the technology is feasible and that the design does indeed have utility against a requirement. In our approach, an advanced development prototype would be completed and evaluated before a commitment is made to full-scale development, and of course, to production.
>
> The second kind is a production, or an engineering prototype. This type is intended both to assure that we have the engineering problems solved and also to permit thorough testing and evaluation of a system. This type of prototype would be very desirable in every program before a substantial commitment to production is made. And, finally, there are prototypes of components and subsystems in advance of, or sometimes concurrent with, engineering development of the main system.
>
> ...The prototype program will provide for competition in real performance and actual hardware and it will require the competing teams to demonstrate the superiority of their products, rather than the superiority of their salesmanship.[1]

Dr. Foster later presented a different way of defining prototypes and their purposes:

> ...In general, prototypes can be broadly categorized as (1) those which precede the decision to go ahead with development of a weapon for the inventory, and (2) those which are used to support subsequent major program decisions after initial go-ahead, DSARC II and III.

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[1] Honorable D. Packard, Deputy Secretary of Defense, statement before the U.S. Senate Committee on Armed Services (9 September 1971).

He called the first category a technology prototype which equates to Packard's advanced development prototype. He called the second prototype within the first category an "operational practicability prototype" which equates to Packard's advanced production or engineering prototype. After the first program decision, a "development prototype" effort precedes and supports the decision to enter full-scale development. The second is the preproduction prototype which insures that engineering is completed and the system is ready for the production line and the production methods, tooling, and procedures are in hand and the production line is ready for the system.[1]

On 12 April 1973, Dr. Foster pointed out the management uses that would be served by prototyping:

- Reduce technical risk before making a large commitment to full-scale development or production.
- Create a situation in which we have choices.
- Exploit technological innovations without waiting for specific requirements to arise.
- Keep design teams viable.
- Improve our ability to estimate costs and trade-off cost and performance.
- Create a competitive environment in which we can stimulate the creativeness and ingenuity of the architects and designers in industry.[2]

4. Combination

The combination development is implicit in the prototyping or competitive design and test system. As soon as the winning design is selected, this design is developed as if it were single source. The required design changes, equipment to be added and subsequent testing are negotiated with the winning contractor. The same procurement management policies would continue to apply in performance trade-offs versus funding. (The B1 low level supersonic capability was traded-off because of cost.) The same priorities of meeting technological requirements rather than time schedule requirements would also apply.

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[1] Dr. J.S. Foster, Jr., statement before the U.S. Senate Committee on Armed Services (9 September 1971).

[2] Dr. J.S. Foster, Jr., FY1974 statement delivered to the House Armed Services Committee (12 April 1973).

C. System Life-Cycle Considerations

1. RDT&E Costs

On 29 February 1972, Dr. Foster stated, the following costing and contracting practices had been ~ were being implemented:[1]

- An independent parametric cost analysis is now required on each major defense system at the key program decision points.
- Greater concentration on the use of production unit cost as a basic design parameter during concept formulation and engineering development.
- Better incentives to encourage the elimination of marginal requirements in systems development that contribute more to cost than to effectiveness.
- Greater emphasis on increasing the readiness and decreasing the life-cycle costs of our new systems by placing greater stress on the achievement of high reliability and easy maintainability--and on demonstrating it in the test and evaluation phase.

DOD Directive 5000-1 lays out the method for structuring the development programs:[2]

> Programs shall be structured and resources allocated to ensure that the demonstration of actual achievement of program objectives is the pacing function. Meaningful relationships between need, urgency, risk and worth shall be thereby established. Schedules shall be subject to trade-off as much as any other program constraint. Schedules and funding profiles shall be structured to accommodate unforeseen problems and permit task accomplishment without unnecessary overlapping of concurrency.

The Air Force and the Navy have regulations (AF 800-2 and SECNAV 5000-1 respectively) similar to the Army regulation that will be documented in some detail below. The procedures are generally the same as they must conform to the DOD Directive 5000-1 which gives relatively broad guidance.

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[1] Dr. J.S. Foster, Jr., DDR&E statement on the FY1973 RDT&E Program before the House Armed Services Committee, pp. 1-22 and 1-23 (29 February 1972).

[2] DOD Directive Number 5000-1, op. cit., pp. 4-5.

AR 1000-1[1] addresses the goals for life-cycle costs as follows:

> Goals for life-cycle costs will be included in development plans which will also include major performance characteristics expressed in terms of allowable bands. Performance characteristics will be stated rather than design specifications. It is intended that the project manager keep performance within the bands specified while remaining within the goals and thresholds established for life-cycle cost, development cost and schedule. Secondary characteristics describing desirable but not necessarily essential features of a system will undoubtedly be generated in the course of the concept formulation process. Generally, trade-offs with respect to the manner of meeting these secondary characteristics will be left to the project manager as the program proceeds, provided such trade-offs do not cause established thresholds to be violated.

AR 1000-1 establishes the Army's basic systems acquisition policies which seek to minimize costs, shorten development time, and assure adequate performance. The regulation describes two systems--one for larger, more expensive systems and another for all others. Six basic policies (listed below) plus specified procedural steps represent the framework of the systems acquisition program for the Army:

(1) Shortened requirements generation time
(2) High level decisionmaking
(3) Shortened development time
(4) Funding priorities
(5) Cost versus quantity
(6) Program cost control

As covered by AR 1000-1, the systems life-cycle processes and their implications prior to procurement are represented by the implementation steps of the acquisition process. The steps and pertinent comments tying in the life-cycle process follow:

- The originator of the requirement submits it to Assistant Chief of Staff for Force Development (ACSFOR). (Note: Who submits the requirement and what it contains is covered in II-B). Four pages is the suggested maximum length for the requirements.

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[1] Army Regulation 1000-1, op. cit., p. 3.

- ACSFOR will obtain augmentation as required from the originator or the concerned commands.
- ACSFOR and the Chief, Research and Development (CRD) will approve the requirement for other than major systems. These will be handled within the Army.
- ACSFOR and the CRD will determine which systems are to be considered major: those which qualify for Defense Systems Acquisition Review Council (DSARC) review and any others which are of critical importance to the Army, expensive, controversial, or for other reasons should involve the Army's top management. ACSFOR assumes processing responsibility and indicates in general terms how the new system will be integrated into the force and resource program. It initiates the key actions.
- Upon DA approval of a major system requirement, a special task force is assembled to prepare the concept formulation package for the Army System Acquisition Review Council (ASARC) and a draft development concept plan. The task force output will support a DA and OSD decision to initiate development. It will include:
  - Systems summary
  - Systems requirement and analysis
  - Discussion of alternatives considered and relationships to other systems
  - Plan for system development
  - Technical portion of the RFP
  - Financial and procurement plan
  - Plan for test and evaluation
  - Personnel and training requirements*
  - Logistical support planning*
- The directive requires that all commands and agencies give active support as required to the Task Force.
- After the system acquisition action is approved by OSD at DSARC a project manager will be appointed and the task force dissolved.

An ASARC system paralleling the DSARC system will be responsible for the ASARC/DSARC preparation. The ASARC has high-ranking principals consisting of the Vice Chief of Staff (Chairman), the Assistant Secretaries (FM), (R&D), (I&L), the Deputy Undersecretary (OR), ACSFOR, Comptroller

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* If the task force recommends proceeding into engineering development.

of the Army and the DCS for Logistics. The ASARC/DSARC phasing and responsibilities are indicated in the table below:

Agency	Milestone	Review
ACSFOR	Enter validation	ASARC I/DSARC I
CRD	Enter full-scale engineering development	ASARC II/DSARC II
ACSFOR	Low rate initial production	ASARC IIa/DSARC IIa
DCSLOG	Full-scale production	ASARC III/DSARC III

Under the basic policy of shortening development time, the Army states the development time "should be shortened to approximately six years from ASARC I to initial operational capability (IOC) when this can be done without inordinate risks." This will require "a willingness to initiate producibility engineering and planning no later than the beginning of engineering and service tests."[1] A summary of the policy is given below:

- All procurement processes should be speeded up so that the contractor can start the validation phase within six months after ASARC I. After completion of the validation phase, ASARC II will make the full-scale engineering development decision and let the contract to the "contractor determined to be the most capable to complete development and first production..."
- Development testing (DT) will be conducted by Army Materiel Command (AMC). Operational testing (OT) will be conducted from prototypes through production models by user troops or individuals preferably in units. Key tests should be completed within six months after test initiation so that the ASARC IIa decision can be made at that time.
- A Producibility Engineering and Planning (PEP) phase (RDT&E funded) should begin no later than the beginning of engineering test even though the funds are at risk if a decision not to go into production is made.

After ASARC IIa, final production engineering, procurement of long leadtime items and hard tooling will be initiated with PEMA (procurement of equipment and missiles, Army) funding and production will be initiated at a low rate. Final DT/OT with low production units should be

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[1] Army Regulation 1000-1, op. cit., p. 4.

accomplished within a maximum of six months. "Operational testing of low rate initial production units is intended to determine:

> a. The overall system's field effectiveness in the hands of troops (benefits versus burdens) to include performance against expected countermeasures.
>
> b. The system's maintainability and reliability within the limits of the test period.
>
> c. The readiness of the system for deployment in terms of basis of issue, organization, tactics, and the training package.

After satisfactory final DT/OT, full-scale production will be authorized by ASARC/DSARC III."[1]

The policy on funding priorities is that the highest priority for exploratory and advanced development funding should be for components and subsystems of future systems that have been identified by the requirements (ROC) approval process.

The policy on cost versus quantity is stated as follows:

> When there is a requirement for sophisticated equipment in order to provide a measure of superiority on the battlefield, it will prove to be expensive and complex. Therefore, the Army must, from the outset, explain the costs in terms of required effectiveness for all or part of the forces in terms of realistic contingency missions. If warranted, we should be prepared to make small buys of critical systems for only part of the total force, accept the high unit cost, and explain it well in advance to OSD and then to the Congress.

The policy on program cost control is expressed as follows:

> ...Extreme care must be exercised to insure that cost estimates realistically represent the acquisition cost of the system and that meaningful cost control over the acquisition process is maintained. Realistic cost estimates are essential for making proper systems analyses and timely trade-off decisions.
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> a. Cost effectiveness studies and trade-off analyses during concept formulation will be based on the best estimate of the ultimate cost of the system. However, the program managers will be responsible for managing their programs against the approved program budget rather than the parametric cost estimates.

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[1] Army Regulation 1000-1, op. cit., p. 5.

> b. Control of development costs must include consideration of the full cost effect of technical changes. In managing within development program cost goals or budgets the managers must be prepared to consider trade-offs involving performance within primary bands, secondary characteristics, and the related savings and should also consider the trade-off of development schedules (IOC) and production and operating costs. Proper consideration of production costs during development will require that "Design to Production Unit Cost" goals be established no later than entry into full-scale development. Such estimates will be stated in contractual documents as "design to" goals.

"Design-to-cost" would affect the policies of the advanced development, engineering development and management and support categories, the categories associated with specific weapons system development. Under the current policy, all systems would fall into design-to-cost categories. The current policy is reflected in DOD Directive 5000-1:[1]

> Cost parameters shall be established which consider the cost of acquisition and ownership; discrete cost elements (e.g., unit production cost, operating and support cost) shall be translated into "design to" requirements. System development shall continuously be evaluated against these requirements. Practical trade offs shall be made between system capability, cost, and schedule.

Under this directive, the policies dealing with advanced development and engineering development would change significantly in that cost would tend to be the driving factor much more than in previous procurement processes. The review process would change to consideration of the denigration of system capability or slipping the schedule to insure meeting the cost goal rather than justifying more funds.

Management and support could be affected by more stringent examination of test requirements. "Can we combine test objectives for less test?" Is this test directly related to the primary function of the weapons system or to an unlikely alternative? Continuing review of the project with such questions as these will tend to maintain primary objectives foremost and also keep costs down.

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[1] DOD Directive Number 5000-1, op. cit.

a. Concept of Design-to-Cost

An extremely good discussion of the meaning of "design-to-cost" and problems of implementing the concept is contained in Dr. James D. McCullough's paper, "Design to Cost--Buzz-Word or Viable Concept."[1]

Dr. McCullough's examination of the design-to-cost concept shows that cost is an important parameter during trade-off studies of a system in the design phase. This implication is contained in DOD Directive 5000-1.

The design-to-cost concept is intended to keep the cost of a system within a given range by making trade-offs between system capability, cost, and schedule.

According to McCullough, five conditions must be satisfied in determining whether or not a system can be procured by a design-to-cost program. The system must:

a. Be in the conceptual stage
b. Represent a low technological risk
c. Have a large production run potential
d. Be subject to competitive procurement
e. Be "cost-effective."[2]

Systems already under development or having high technological risk could not be governed by the concept.[3] Systems requiring very limited numbers such as the Over-the-Horizon (OTH) radars would be excluded. Sole source developments do not lend themselves to design-to-cost controls because there is no overriding pressure (e.g., loss of contract to a competitor at a milestone in development) either to keep costs down or the design competitive. Finally, the design-to-cost application must be more cost-effective than existing procurement procedures or there would be no use in implementing it.

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[1] J.D. McCullough, "Design to Cost"--Buzz-Word or Viable Concept?", Institute for Defense Analyses, Cost Analysis Group (July 1973) UNCLASSIFIED.

[2] Ibid., pp. 13-15.

[3] In a discussion on 19 February 1974, Mr. McCullough told me that, as far as he knew, his constraints directed toward making design-to-cost a viable policy had been generally ignored and that design-to-cost was being used as stated in DOD Directive 5000-1.

b. Effects of Design-to-Cost

The acceptance of McCullough's five conditions would split the major systems acquisition programs into two major categories--possibly more. The design-to-cost concept stresses competitiveness; the single source contractor would not proceed in a competitive vein. Therefore, systems being developed on the sole source basis could be administered awkwardly at best. Areas of high technological risk would fall outside the best application of the concept directly as a result of the uncertainty. The program implementation policies might then have to be designed in two families: (1) the systems logically falling into the design-to-cost concept, and (2) those which did not. Unfortunately, the dividing line would not be that clear. Some major systems would have subsystems which could be designed to cost. Some apparently straightforward projects might have unforeseen difficulties which might take them out of the design-to-cost area in midstream.

There would be no direct effect on requirement policies and there should not be. The combat organization or its representative command should state actual requirements as seen by the user. The indirect effect will probably be a more stringent examination of the subordinate requirements of systems with many requirements. When the users realize the rules for review, the monies available, and the requirements for justification of each sub-system (in terms of frequency of use in a combat situation), they may be more design-to-cost conscious in stating their requirements. Certainly, this will be true at all review levels. McCullough believes that the basic process of defining requirements remains unchanged.[1]

2. RDT&E to O&M/MPA Costs

Dr. Currie recently addressed the O&M (downstream) costs as a major consideration in development:

> While a small fraction of...total cost is spent during development, a large fraction of the cost of ownership relates directly to the design approach taken during the early stages of a program. This leverage must be exploited to reduce the downstream costs by properly structuring the development programs. Weapon systems must have affordable production

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[1] McCullough, op. cit., p. 11.

costs, high reliability, low maintenance and be capable of operation by the minimum number of low skill level personnel.

The Deputy Secretary of Defense recognizes the need to better address the downstream costs (i.e., maintenance and support) and to more effectively manage their related resources. On 25 January 1974 he directed the establishment of an OSD/Tri-Service task group that will in the next four months develop a recommended phased implementation plan for providing visibility of these costs by weapon/support system and the means for more effective management and accounting of these costs.[1]

...There is one very important trade-off that cannot be made: Design-to-Cost is not a license to trade-off downstream costs (operating and maintenance) for reduced acquisition costs. To enforce this, thresholds are established in the Development Concept Papers on those factors that influence downstream costs the most, i.e., reliability, maintainability, maintenance hours per hour of operation, maximum crew size and support requirements. The breach of such a threshold related to operation or maintenance is considered equally as serious as the breach in a performance or cost-related threshold...Termination will be recommended during R&D of those programs that cannot meet their planned total program costs.[2]

D. System-to-System Considerations--Commonality of Production and Commonality of Use

Eberhardt Rechtin included the following actions in this area in an article for the December 1971 AIAA magazine:[3]

Harder choices in weapon-system development must be made, including cost-enforced commonality, increased interest in allied weapon developments and more specific response to Russian developments than in the past. DOD is digging into the problem of simultaneously increasing the frontline combat capability

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[1] Currie, "DOD RDT&E FY1975 Program," pp. 9-6 and 9-7.

[2] Ibid., pp. 9-17 and 9-18.

[3] E. Rechtin, Principal Deputy, ODDR&E, "Slackening R&D is No Way to Maintain National Power," *Astronautics and Aeronautics*, p. 27 (December 1971).

while reducing the long logistics tail and other manpower costs--one probable approach is to improve the maintainability of our equipments. DOD probably is going to have to turn away from the extremely high-performance weapons systems with per-unit costs so high that not enough can be procured to be effective as a fighting force.

These actions simply acknowledge that, in a world of rapidly changing technologies, the future will belong to those who invest in it today.

In a 5 December 1973 speech to the R&D Symposium of the National Security Industrial Association, Dr. Walter LaBerge, Assistant Secretary of the Air Force (R&D), said that the Air Force was moving towards a basic products line. For all systems, this means common radios, common instruments and other common items for different aircraft, missile and other equipment. He recognized that this seemed foreboding for competition when competition was being emphasized in all new development, but he said the policy would be to use more than one manufacturer for a product line--a policy that would spread the work somewhat. For these items the Air Force wants to be able to select from a range of prices and capabilities of equipment on the shelf.

The Honorable Robert C. Seamans, Jr., Secretary of the Air Force, has stated, "We are placing particular emphasis on the development of modular weapons having interchangeable components. Such weapons would permit a significant savings in development, production, and training costs."[1]

Dr. Malcolm R. Currie gave many examples which showed the trend toward the commonality of systems, subsystems and components. Several quotations containing some of these examples are as follows:[2]

Additionally, TRIDENT I is being developed to be compatible with the current POSEIDON SSBNs as well as the new submarine.[3]

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[1] Honorable R.D. Seamans, Jr., Secretary of the Air Force, presentation to the Committee on Appropriations, U.S. House of Representatives, Budget Estimates, FY1974 (8 May 1973).

[2] Currie, "DOD RDT&E FY1975 Program".

[3] Ibid., pp. 2-6.

Although such a version [cruise missile] operates in a different environment, we are taking steps to assure close integration and commonality of effort. Both will use the same engine technology (developed by the Air Force); both will use the same terrain comparison guidance techniques now being brought to perfection by the Navy. Each program office will station permanent liaison officers with the other.[1]

HELLFIRE has been conceived as a modular missile able to accept a variety of seekers.[2]

Strong action has been taken to eliminate duplication in laser-guided missile developments. Our goal has been a common laser-guided missile for fixed-wing aircraft of the Air Force, Navy and Marine Corps and a common seeker for all the Services.[3]

Modularity is being emphasized to achieve a high degree of commonality and resultant savings. This effort is being closely monitored to achieve maximum benefits from the modular approach.[4]

...We are developing the Target Acquisition System (TAS) to be used with SEA SPARROW and other short-range defensive weapons. It will consist of a modular automatic tracking radar, a manual tracking radar, and an independently-mounted infrared search set. This modular approach will enable the Navy to acquire a fully-integrated system for ships designed to operate in high threat areas and selectively install certain modules on ships to operate in lower threat areas.[5]

Maximum use of common equipment and ground terminal compatibility with airborne systems will be required between the Army and the Air Force because their roles are mutually supporting.[6]

We are developing, under Navy cognizance, a common, low-cost data link which will have the ability to control the MGGB II, WALLEYE stand-off capability and CONDOR stand-off capability.[7]

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1 Currie, "DOD RDT&E FY1975 Program," pp. 2-10.

2 Ibid., pp. 4-8.

3 Ibid., pp. 4-8.

4 Ibid., pp. 4-11.

5 Ibid., pp. 4-28.

6 Ibid., pp. 4-35.

7 Ibid., pp. 4-45.

The multiplicity of guidance technologies and warheads for air-launched weapons creates a management problem; development of a variety of seekers and warheads is possible, but it is neither necessary nor economical to build a new missile to incorporate each new development. The concept of the Modular Weapons Family is to prevent weapon proliferation by controlling interfaces so that various modules are interchangeable.[1]

The joint strategy stresses equipment commonality, modularity, and interdependency and already has resulted in the savings of several million of R&D dollars.[2]

However, planned and coordinated reduction of this duplication could result not only in some overall R&D savings within the Alliance, but even greater savings in common logistics support, and in the vastly increased operational effectiveness of commonality.[3]

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1 Seamans, op. cit., pp. 4-46.

2 Ibid., pp. 7-15.

3 Ibid., pp. 9-32.

V DOD PROGRAM MANAGEMENT POLICIES

A. Responsibility

DOD program management policies are continually being adjusted in efforts to improve the productivity and efficiency of RDT&E. In FY1970 more authority was delegated to the Services to run R&D programs after they were approved than had been true before that time. This action made the program managers accountable for the development and production of major defense systems and, at the same time, layers of authority between the program manager and his component head were directed to be reduced to a minimum. The Services themselves were made responsible for identifying needs and defining, developing, and producing systems to satisfy these needs. DDR&E then concentrated more on policy, rather than the detailed management of weapons systems. A CSIS report gives further details:

> The budgetary process was opened to greater participation of the Services, although 1950s-style separate Service R&D budgets, unexamined by ODDR&E, were not reinstituted. Day-to-day program management became a Service responsibility. Program managers were more carefully selected and given more authority, more incentive and more time on the job. OSD continued to provide the strategic and fiscal guidance for decisions, but there was more involvement by the Joint Chiefs of Staff. The individual Services were given a larger role in determining resource requirements and system priorities and in reprogramming.[1]

In 1971, the Secretary of Defense directed each of the military services to designate a major field command (or a limited number of major field agencies), separate from the developing/procuring command to be responsible for OT&E.[2] As a result, the designated commands were

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[1] The Center for Strategic and International Studies, (CSIS) "U.S. Military R&D Management," Special Report Series No. 14, Georgetown University, p. 20 (Washington, D.C. 1973).

[2] Memorandum from David Packard, Secretary of Defense, to Secretaries of the Army, Navy, and Air Force, Chairman of the Joint Chiefs of Staff, and DDR&E, "Conduct of Operational Test and Evaluation" (11 February 1971).

restructured, and the results of their test and evaluation activities were to be reported directly to their service chief. At the same time within the service headquarters staff there, an OT&E office was to be set up to assist the service chief. A Deputy Director for Test and Evaluation was added to DDR&E staff, with responsibility for reviewing and approving test and evaluation plans of the services and assessing the results.[1] He also has responsibility for coordinating and reviewing the test and evaluation of foreign systems for possible DOD use.

In FY1973 a number of R&D programs were transferred to a joint DOD program effort, with the lead responsibility assigned to one of the military departments or ARPA. This move was made in order to reduce duplication and increase standardization. In addition, multiservice testing is being increasingly emphasized.

B. Management Tools

A number of management tools, in the form of coordinating and concept papers, have been developed and implemented in recent years. These include: Technology Coordinating Papers, Area Coordinating Papers, Mission Concept Papers, Development Concept Papers, and Program Memorandums.

The Technology Coordinating Paper (TCP), introduced in 1970, is a summary and analysis document for a selected technical or scientific area within the technology base. Through the TCP framework, the Services (and the defense agencies, where appropriate) bring together technical and managerial people working in a specific technical area to prepare a common strategy. TCPs are not prepared for most technology base programs that are under single component management, such as the Army, Navy and Air Force. The TCP defines specific technological advances in the subject area that are needed to meet future military requirements and to solve current problems. It identifies DOD technology programs, in progress or planned, and points out specific technological gaps that should be filled. As of February 1974, all of the 11 TCPs originally planned had been written, covering more than 80 percent of the technology base.

[1] DOD Directive 5000.3, 19 January 1973.

The Area Coordination Paper (ACP), also introduced in 1970, summarized military needs and capabilities with respect to a specific defense mission. It related those needs to the systems expected to be available in order to satisfy requirements of the total defense mission. Its purpose was to aid the Secretary of Defense in decisions relating to the adequacy of current capabilities, undesirable overlaps, and gaps that should be filled.

Dr. Currie in his presentation to Congress on 26-27 February 1974 stated that Mission Concept Papers (MCPs) will replace the ACPs. The MCPs are an attempt to broaden the context of the ACPs by including the environment within which the systems are to operate. That is, they will include statements about the threat analysis and the force structures. The MCPs will also concentrate more on tradeoffs and alternatives, given limited resources such as fiscal constraints. A few MCPs have been written, and these papers are still in the experimental stage.

Although the use of Development Concept Papers (DCPs) began in late 1967, they have become an increasingly important management tool in recent years. (In FY1973, the DCPs controlled almost 70 percent of RDT&E systems development dollars.)[1] The DCP is a document for the Secretary of Defense which represents the rationale for starting, continuing, or stopping a major development program at critical decision points. It defines the program issues, objectives, plans, performance parameters, areas of major risk, system alternatives and acquisition strategy.[2] The key performance goals form basic milestones that are monitored by the Defense Systems Acquisition Review Council (DSARC), which was created in 1969. DSARC is made up of DDR&E, the Assistant Secretaries of Defense for I&L and for Systems Analysis, and the Comptroller. The meetings are

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[1] Senate Hearings, DOD Appropriations FY1974, p. 490.

[2] DOD Directive No. 5000.1, 13 July 1971, p. 3.

attended by the Service secretaries and the Chairman of the Joint Chiefs of Staff. The monitoring is done when the program reaches critical milestones and, if the Council believes that the program should go forward, it then requests a decision from the Secretary of Defense.

The DCP prepared for use at the time of the program initiation decision (first milestone) identifies the critical questions and areas of risk. It also provides a summary statement of test objectives, schedules, and milestones. At the time of decision for full-scale engineering development (second major milestone), the revised DCP gives the results of test and evaluation, an updated statement of critical questions and areas of risk, and a detailed statement of test plans and milestones.[1] Full production go-ahead (third major milestone) is authorized by approval of the DCP. With this process, additional program commitments are made only after certain goals have been achieved.

Program Memorandums (PMs) are similar to DCPs but are simpler, less formal documents. They are used for smaller programs than the DCPs.

The policy of including the Services in the DCP/DSARC process is believed to help prevent unnecessary duplication and to increase interdepartmental cooperation.

The DSIS report described the process as follows:

> Each step, from early research through exploratory development, advanced development, and engineering development, is guided by stated policies, overseen and controlled by OSD groups and managed by the Services. The early steps in the process are guided by Technology Concept Papers, which outline what is being done, what is feasible in technology areas, and what is needed in 5 to 15 years. As the work moves closer to direct military orientation, it is guided by Area Coordinating Papers. When the concept of a specific military system has been attained by this early exploration, a Development Concept Paper, defining the weapon to be developed and why and how it is to be done, guides the process until production is decided.[2]

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1 DOD Directive 5000.3, 19 January 1973.

2 CSIS, op. cit., p. 22.

VI PERFORMER POLICIES

A. Overview

DOD RDT&E is performed mainly by industry and DOD itself (government in-house) with federal contract research centers and universities performing less than 7 percent of the total research for any one year in the past five. Table VI-1 shows that approximately two-thirds of the total is performed by industry and almost one-third by DOD laboratories over the seven-year period shown. However, testimony in 1971 indicated that half of the in-house funds were returned to industry. The Services, for the most part, decide whether development will be performed in-house or by industry. If it goes to a Service laboratory, then that laboratory determines the amount between the work that it will do and the amount it will contract to industry or the universities. Development work is usually contracted out to industry.

B. In-House Laboratories

The DOD laboratories that were fragmented along relatively narrow technological areas were combined into larger aggregations with broader responsibilities in FY1970. There are now 100-some in-house laboratories. Some concentrate on basic research, others are technologically oriented, and others perform only testing. The in-house laboratories, in addition to performing some of their own research, provide scientific and engineering advice on contract research and development programs, and manage weapons systems development and test programs.

C. Federal Contract Research Centers (FCRCs)

FCRCs are organizations that undertake R&D activities almost entirely on a sole-source basis for the federal government. They are administered by industrial firms, nonprofit organizations, universities and colleges.

Table VI-1

PERFORMER DISTRIBUTION OF DOD RDT&E
(based on TOA)
(Percent)

	1968	1969	1970	1971	1972	1973	Budget Request 1974
Industry	65.3	63.4	67.2	61.3	64.4	65.5	65.6
Government In-House	27.8	30.4	27.2	33.3	30.0	29.5	29.2
Federal contract research centers	3.5	3.0	2.6	2.7	2.7	2.3	2.4
Universities	3.2	3.1	3.0	2.7	2.9	2.7	2.8
Foreign performers	0.2	0.1*		n.a.	n.a.	n.a.	n.a.
Emergency fund	-	-	-	-	-	-	-
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Includes only research and exploratory development.

Sources: Senate Hearings, DOD Appropriations, FY1970, p. 197; FY1971, p. 440; FY1972, p. 408; FY1973, p. 646; and House Hearings, DOD Appropriations, FY1974, Part 7, p. 476.

As a result of a conviction that DOD should increase its in-house R&D capabilities, a concern that FCRCs were becoming too large and costly, and were not competitive with private organizations, Congress in 1971 imposed ceilings on the amount that DOD could contract with the FCRCs. As a result, funds for four out of seventeen of these centers were substantially cut, others were reduced, and others were removed completely from FCRC status. As Table VI-1 indicates, TOA for FY1973 for the FCRCs, expressed as a percent of total DOD R&D funds was only 2.3 percent, down from 2.7 percent in FY1971 and FY1972. Table VI-2 shows the funds (in millions of constant dollars) for the FCRCs, as well as for the other performers.

In 1972 for the first time, a clearly defined proposed policy for DOD-FCRC relationships was stated by the Director of Defense Research and Engineering. The main points of the policy consisted of the following:

> Based on current needs of the Department of Defense, special institutions categorized as FCRCs will continue to be utilized, but under closer management controls than heretofore.
>
> In recognition of their special characteristics, the content of the tasks assigned to FCRC organizations will be thoroughly reviewed to assure that they cannot be performed effectively and objectively by other organizations.
>
> Due to their special position compared with other organizations, limits will be placed on the amount of work assigned to FCRCs. These limits will be in the form of professional manpower limitations.
>
> Because of the diverse nature of the tasks assigned to the FCRCs, the manpower limitations to be placed on these organizations will differ according to the type of task and the type of organization involved.
>
> Since some advantages of competition among FCRCs can be obtained by authorizing a single total ceiling for each class of FCRC in lieu of individual FCRC budget line items, funding for these organizations will be derived from various other program elements.
>
> In view of the wide range of activities performed by the FCRCs for the Services, Defense Agencies, and the Office of the Secretary

Table VI-2

PERFORMER DISTRIBUTION OF DOD RDT&E
(Million Constant 1970 U.S. $)

	1968	1969	1970	1971	1972	1973	Budget Request 1974
Industry	5284.8	5211.2	5007.0	4128.0	4363.5	4519.4	4605.6
Government in-house	2248.7	2502.6	2023.4	2240.5	2029.7	2034.2	2054.5
Federal contract research center	279.4	245.1	192.8	181.6	182.4	157.0	171.1
Universities	259.8	255.9	227.7	181.7	196.3	184.9	191.3
Foreign performers	14.5	9.8	n.a.	n.a.	n.a.	n.a.	n.a.
Emergency funding	-	-	-	-	-	-	-
Total	8087.3	8224.5	7450.9	6731.7	6771.9	6895.5	7022.5

NOTE: Totals may not add due to rounding.

Sources: Senate Hearings, DOD Appropriations, FY1970, p. 197; FY1971, p. 440; FY1972, p. 408; FY1973, p. 646; and House Hearings, DOD Appropriations FY1974, Part 7, p. 476.

of Defense, the management of the allocations to the various organizations within the total ceiling constraints will be the responsibility of the Director of Defense Research and Engineering.

To insure that these policies are properly implemented, either a Military Service or Defense Agency is to be assigned specific responsibility for each FCRC. Conflicts between users concerning requests for these resources will be adjudicated by DDR&E.

The annual authorization and appropriation process will continue to be used to report to the Congress progress in managing these organizations, the results of their work, and of the plans for the forthcoming year. This will include the projected ceilings for each group of organizations subject to the principles proposed above.[1]

As a result of this policy, personnel ceilings were established considerably below the previous highs for six of the FCRCs, and three were removed from FCRC status altogether, leaving only nine FCRCs.[2]

D. Universities

At the urging of Congress in 1966, R&D programs were funded at universities that previously had received little in the way of DOD funds. (This was an experimental program called THEMIS.) The program was cancelled by Congress in 1970, but 37 of the 108 research centers developed under this program were continuing with defense contracts in FY1972, although they received no special consideration in that year. In order to continue a broad base of research in the universities, defense scientists visit colleges and universities in the nation to acquaint them with DOD's objectives and interests. The expectation is that this will lead to funding of new research teams that have ideas useful to defense. For FY1974, it was

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1 Report No. 92-962, Committee on Armed Services, U.S. Senate, p. 100 (14 July 1972).

2 Dr. M. R. Currie, statement before the Committee on Armed Services of the U.S. Senate, 26-27 February 1974, pp. 7-34.

anticipated that DOD R&D work would be contracted out to some 200 universities and colleges.

E. Foreign Performers

In FY1969 DOD took actions to reduce research funds at foreign institutions and cut the number of DOD research personnel in Europe. At the same time, tighter and more explicit policy criteria and revised funding guidance were issued. Table VI-3 reflects the former actions, and although DOD expressed a continuing need for some foreign R&D--such as research that deals with unique environmental or geographic characteristics--the funds were not reported separately after FY1969. As a result of direct questioning in the House Appropriations Hearings, however, Dr. Foster did give the funding for foreign performers in FY1970 as $3.7 million for FY1970 and $3.0 for FY1971.[1]

F. Summary

Of the total research and exploratory research funds, approximately half is expended at government laboratories and test facilities. The allocation of research and exploratory development among performers for FY1974 is shown below:[2]

	Percent
Industry	35
Government in-house	48
Universities	14
FCRCs	2
Total	100

[1] House Appropriation Hearings FY1972, Part 6, p. 124.

[2] Currie, "DOD RDT&E FY1975 Program," pp. 7-43.

DOD laboratories are a major source of new technology and system components, as well as technical intelligence analysis. They are a primary source for bringing technological research activities together with military requirements. Industry contributes in areas of concept formulation and provides development, engineering, testing and production support. The universities provide new basic concepts, and (particularly through graduate study programs) provide many of the experts working at the forefront of scientific disciplines. Universities also operate a number of important research and development laboratories. The Federal Contract Research Centers provide objective and independent technical, policy and strategy analyses and feasibility demonstrations.[1] Because they have access to privileged information, they are in a unique position to serve the defense establishment.

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[1] Senate Hearings FY1972, p. 400.

APPENDIX D

DEFENSE R&D OBJECTIVES

I INTRODUCTION

The purpose of this paper is twofold:

- First, to describe current approaches to the formulation of research and development (R&D) objectives within the Department of Defense (DOD).[1]
- Second, to identify and provide an example of the type of objective which should be developed to support a larger task: the generation of alternative R&D strategies.

This paper is designed to support the study "Alternative U.S. Research and Development Strategies." It emphasizes approach and methodology rather than the substance of R&D objectives.

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[1] Throughout this paper the R&D effort addressed is that of the Department of Defense and selective components, including the JCS, the Service Departments and Services but excluding DIA, DCCA, DIS, DMA, DNA, DSA and other separate departments and agencies.

II THE NATURE OF CURRENT R&D OBJECTIVES

A. Definition

There appears to be no officially recognized or universally accepted definition of the term "objectives" in the directives or literature on R&D. In a sense, the lack of consensus on what an R&D objective is works to the advantage of one addressing the subject, for the investigator is not constrained by prevailing usage in posing a definition. In the generic sense, the Department of the Navy RDT&E Management Guide does provide the following definition which will be useful for our purposes:

> OBJECTIVE--A goal, expressed as that portion of the "what", "when", and "where" of a requirement which is reasonably feasible of attainment within the expected availability of the resources of men, money and technological capability.[1]

B. Objective Documents and Systems

Although there appears to be no official definition of an "R&D objective," objectives which generally parallel the definition cited here are routinely addressed in a number of documents within the R&D cyc documents and systems are generated at several levels within D the Office of the Secretary (OSD), at the Joint Chiefs of St within the Services. Citation and description of these exis and systems is a necessary prelude to establishing criteria o generating alternative strategies.

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[1] From the Navy Programming Manual as cited in Department of the Navy RDT&E Management Guide, Part I System Description, NAVSO P-2457 (Rev 7-72), p. A-8 (1 July 1972). (Hereinafter referred to as RDT&E Management Guide).

[2] See Table 1 for a graphic representation of the R&D cycle.

Table 1 THE R&D CYCLE

	RESEARCH	EXPLORATORY DEVELOPMENT	ADVANCED DEVELOPMENT	ENGINEERING DEVELOPMENT	OPERATIONAL SYSTEMS DEVELOPMENT
	← TECHNOLOGY		→	← WEAPONS DEVELOPMENT	→
BASIC ORIENTATION	SCIENTIFIC	SCIENTIFIC	SCIENTIFIC	ENGINEERING (SYSTEMS ENGINEERING	ENGINEERING (PRODUCTION ENGINEERING
BASIC PURPOSE	TO EXPLORE THE UNKNOWN	TO ACQUIRE KNOWLEDGE OF SELECTED THEORETICAL APPROACHES VIA LABORATORY TEST	TO ACQUIRE KNOWLEDGE OF NATURAL PROCESSES THROUGH EXPERIMENTAL TEST	TO PERFORM SYSTEMS ENGINEERING PROGRAM DEFINITION PHASE, OPS CONCEPT & COST EFFECTIVENESS	TO PERFORM SYSTEMS ACQUISITION (OPERATIONAL)
END PRODUCT	KNOWLEDGE OF FUNDAMENTAL NATURAL PROCESSES	A REPORT A BENCH MODEL FOR FEASIBILITY CHECK AN EXPERIMENTAL COMPONENT	MAJOR HARDWARE ITEM FOR EXPERIMENTAL TEST	A COMPLETE SYSTEM WHOSE ENGINEERING DESIGN OPS, CONCEPT, AND COST EFFECTIVENESS HAS BEEN CONFIRMED	PRODUCTION ITEM FOR USE BY OPERATIONAL COMMAND
DIRECTION OF EFFORT	NOT DIRECTED TOWARD SOLUTION OF MILITARY PROBLEMS	DIRECTED TOWARD SOLUTION OF MILITARY PROBLEM – SHORT OF DEVELOPMENT HARDWARE FOR EXPERIMENTAL TESTING	DIRECTED TOWARD SOLUTION OF MILITARY PROBLEM – TO INCLUDE DEVELOPMENT OF HARDWARE FOR EXPERIMENTAL TEST	DIRECTED TOWARD THE ACQUISITION OF DATA NEEDED TO MAKE A JUDGEMENT CONCERNING WHETHER OR NOT TO "GO OPERATIONAL" (DESIGN/COST OPS/DATA)	DIRECTED TOWARD ACQUISITION OF OPERATIONAL SYSTEM FOR AF INVENTORY
MANAGEMENT GROUPINGS	BY ACADEMIC DISCIPLINES • PHYSICAL SCIENCES • ENVIRONMENTAL SCIENCES • MATHEMATICAL SCIENCES • PSYCHOLOGICAL SCIENCES • BIOMEDICAL SCIENCES	BY SUBJECT TITLES • SPACE • ELECTROMAGNETIC • MATERIALS • FLIGHT CONTROL ETC.	BY HARDWARE CATEGORIES 1 AERONAUTICS 2 SPACE 3 BALLISTIC MISSILES 4 ELECTRONICS	BY HARDWARE CATEGORIES 1 AERONAUTICS 2 SPACE 3 BALLISTIC MISSILES 4 ELECTRONICS 5 OPS SUPPORT	BY FORCE STRUCTURE 1 STRATEGIC FORCES 2 DEFENSIVE FORCES 3 GENERAL PURPOSE FORCES 4 AIRLIFT FORCES 5 GENERAL SUPPORT FORCES
REQUIREMENT	DO NOT REQUIRE SPECIFIC MILITARY PROBLEM	DO NOT REQUIRE SPECIFIC HARDWARE PAY-OFF	BEGIN TO QUESTION MILITARY UTILITY	SPECIFIC MILITARY MISSION OR USE DEFINED IN DETAIL INTEGRATED WPN SYS, OR MAJOR COMPON OR SUB-SYS	SPECIFIC OPERATIONAL REQUIREMENT INCLUDING NUMBER OF SIGHTS & HARDWARE UNITS
TECHNICAL RISK	HIGH	HIGH	HIGH	MODERATE	LOW
EXAMPLES	PLASMA DYNAMICS CRYSTAL PHYSICS COSMIC RADIATION NETWORK THEORY MAN-MACHINE RELATIONS BIOMATHEMATICS	AUTOMATIC TERRAIN AVOIDANCE ADVANCED ICBM GUIDANCE LAMINAR FLOW CONTROL NEW PROPULSION CYCLES COMPUTER TECHNOLOGY RECONNAISSANCE TECHNIQUES	AERONAUTICS X-15 – V/STOL & VTOL ACFT LAMINAR FLOW AIRCRAFT MACH 3 RAM JET SPACE MOL – ASSET ION ENGINE BALLISTIC MISSILES STELLAR INERTIAL GUIDANCE ADVANCED ICBM TECHNOLOGY HIGH ENERGY SOLID PROPELLANTS ELECTRONICS REMOTE DETECTION COIN RADAR ADVANCED AIRBORNE WARNING	AERONAUTICS XB-70 CX-HLS SPACE TITAN III ATLAS-AGENA SPACE DEFENSE BALLISTIC MISSILES ADVANCED REENTRY ELECTRONICS INTELLIGENCE DATA HANDLING OPS SUPPORT AIRCRAFT FLARE	STRATEGIC FORCES ATLAS-TITAN-MINUTEMAN DEFENSIVE FORCES SPADATS GENERAL PURPOSE FORCES F-111A AIRLIFT FORCES C-141 GENERAL SUPPORT SUPPORT TO ALL WEAPON SYS
MANAGEMENT TECHNIQUES	BASIC – ABSOLUTE MINIMUM DIRECTION "BIASED" BASIC – MINIMUM DIRECTION	REASONABLY SPECIFIC OBJECTIVES; MINIMUM APPRAISAL	SPECIFIC OBJECTIVES, FLEXIBLE SCHEDULES, APPRAISAL	FIRM OBJECTIVES, SCHEDULES AND APPRAISAL	FIRM OBJECTIVES, SCHEDULES, AND APPRAISAL
	← NOT APPROVED FOR THE OPERATIONAL INVENTORY			→	← APPROVED →

SOURCE: Defense Industry Bulletin, September 1965 as provided in "National Security Management, Defense Research and Development" Industrial College of the Armed Forces, 1968

C. The PPBS

The DOD Planning, Programming and Budgeting System (PPBS) provides a starting point for describing current systems for stating R&D objectives.[1] A portion of the PPBS cycle as it relates to R&D objectives is displayed graphically in Table 3. Cycle components are described below:

- The Joint Intelligence Estimate for Planning (JIEP) together with the Joint Long Range Intelligence Estimative Document (JLRIEP) (developed by the JCS, the Services and the Defense Intelligence Agency) provide the principal intelligence input for the entire PPBS cycle. The JIEP is developed in three volumes which focus on short-, mid- and long-range forecasts. R&D objectives are eventually generated from Volumes I and II, the long- and mid-range forecasts, respectively.
- Service objective plans address the mid-range period. They provide Service positions on strategy, objective force levels, resource requirements and justification for R&D.
- The Joint Strategic Objectives Plan (JSOP), developed by the JCS and the Services, provides the principal military advice of the JCS to the Secretary of Defense in developing the budget on force levels and related issues. Volume II of JSOP has a section on modernization requirements.
- The Defense Policy and Planning Guidance Memorandum (DPPGM), drafted in the Office of the Secretary of Defense (OSD), is prepared after review of Volume I of the JSOP and provides guidance for the preparation of Volume II.
- The Joint Long Range Strategic Study (JLRSS), developed by the JCS and the Services, provides the views of the JCS concerning the role of U.S. military power in the long-range period and outlines broad strategic implications which should be considered in formulation of R&D objectives.

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[1] Throughout this paper the focus is upon research and exploratory development as a component of the overall Research, Development, Test and Evaluation (RDT&E) process. In terms of the RDT&E Five Year Defense Program (FYDP) categories 6.1 through 6.6, this paper addresses categories 6.1 (research) and 6.2 (exploratory development) which together constitute the bulk of the technological base. The six FYDP categories are displayed in Table 2.

Table 2

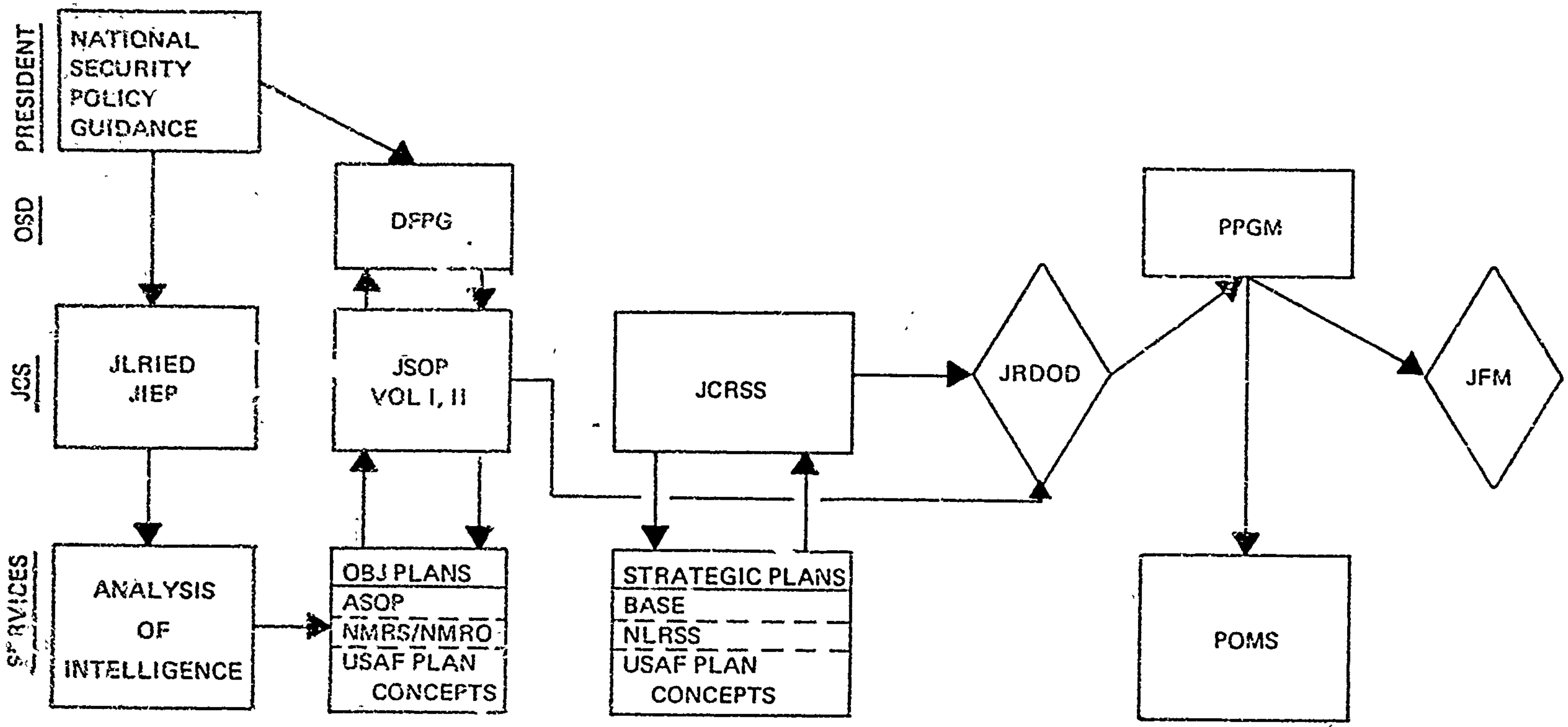
RDT&E PROGRAM 6[1] CATEGORIES

RESEARCH	DEVELOPMENT				TEST AND EVALUATION
	EXPLORATORY	ADVANCED	ENGINEERING	MGMT SUPPORT	
6.1	6.2	6.3	6.4	6.5	6.6
TECHNOLOGICAL BASE					

1 The entire defense effort within the FYDP has been organized into 10 major programs. Program number 6 is the RDT&E effort.

Table 3

FORMULATION OF R&D OBJECTIVES IN THE PPBS CYCLE



LEGEND: ◇ Documents which provide R&D objectives.

ASOP — Army Strategic Objectives Plan
BASE — Basic Army Strategic Estimate
DPPG — Defense Policy and Planning Guidance Memorandum
JFM — Joint Force Memorandum
JIEP — Joint Intelligence Estimate for Planning
JCREID — Joint Long Range Estimative Intelligence Document
JRDOD — Joint Research and Development Objective Document
JSOP — Joint Strategic Objectives Plan
NLRSS — Navy Long Range Strategic Study
NMRS — Navy Mid Range Study
NMRO — Navy Mid Range Objectives
POM — Program Objectives Memorandum
PPGM — Planning and Programming Guidance Memorandum

- Service strategic plans are the primary Service inputs into the JLRSS and JRDOD.
- The JRDOD, developed by the JCS and the Services, evolves from the JSOP and JLRSS by:
  - Translating broad strategic guidance on operational requirements into the R&D objectives considered essential.
  - Providing advice to OSD regarding the relative military importance of the R&D effort.
  - Providing guidance to the Services for their R&D planning.

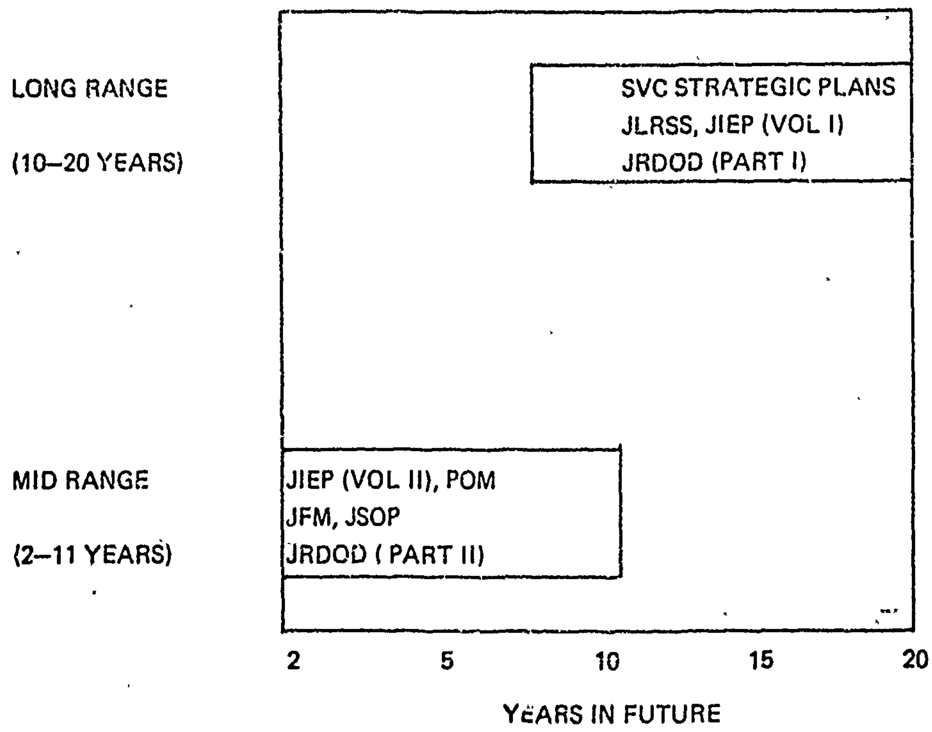
  The JRDOD assists the Secretary of Defense in developing the DOD R&D program. The plan is produced annually, includes inputs from the Unified and Specified Commanders and the Services, and provides a detailed listing of R&D objectives by priority.
- The PPGM is issued to the JCS and Secretaries of the Military Departments by OSD to provide force planning fiscal levels and support planning guidance.
- The JFM, developed by the JCS and the Services, delineates the major force and force-related issues which are judged to be important for the current year. It compares alternate costs between the approved FYDP and other submissions. The JFM contains an R&D Annex which provides the views of the JCS concerning the R&D objectives which should be pursued within the constraints of the FYDP. The Annex addresses statements of R&D priorities which are contained in both the JRDOD and the Area Coordinating Papers (ACPs).
- The Service POMs developed within each military department are submitted to OSD and provide force, manpower costs and materiel recommendations.

The time frames covered by the documents most applicable to R&D objectives which have been cited here are illustrated in Table 4.

Of all the documents within the PPBS the JRDOD is the most significant for the development of R&D objectives. The JRDOD, which was first published in 1967, covers a period of eighteen years with emphasis on the two to eleven year (mid-range) objective era. Objectives are arranged according to the program element which they support in the FYDP. The JRDOD designates R&D priorities as "critical," "high priority" or "priority." Objectives are generally described in terms of systems or equivalent levels of organization such as:

Table 4

R&D RELATED DOCUMENT TIME FRAMES



- Tactical nuclear weapons systems
- Command, control and communication systems
- Combat area command and control systems
- Area denial and barrier weapon systems
- Antitank weapon systems
- Tactical target information and acquisition systems.

Time urgencies may be specified. Justification for development may be cited for individual objectives.

The 1970 report of the Blue Ribbon Defense Panel was critical of the entire R&D planning system including the objective definition--"There is no adequate or coherent planning for investments in advancing the technological base."[1] The same group recommended ". . an annual Research Objective (RO) statement which would be a companion document to the Operational Capability Objectives developed by the Unified commands and which would provide the Secretary of Defense an information base to determine the overall defense capability objectives."[2] A 1972 U.S. General Accounting Office (GAO) report, in addressing objectives, proposed a 10 to 30 year time frame for predicting military needs within the technological base rather than the 2 to 20 year forecast found in the JRDOD.[3] The same report was critical of the results found in the JRDOD:

> Our study was limited to screening the February 1971 JRDOD. It contained the Services' descriptions of their engineering development priorities as opposed to their longer term scientific objectives and priorities. It included the Army's top priority hardware needs, listed as "The Big Eight," for operating in the 1975-80 combat environment.

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1 "Report to the President and the Secretary of Defense on the Department of Defense by the Blue Ribbon Defense Panel," p. 66 (1 July 1970).

2 Ibid., p. 67.

3 "Observations on the Planning of Research and Exploratory Development," United States General Accounting Office.

> Although JRDOD may be useful as a top-level planning document, it is not specific or selective enough to meaningfully direct and guide the military services in planning individual research and exploratory development programs and projects.[1]

At least for the purpose of our overall study effort on R&D strategies, the objectives cited in the PPBS cycle appear to be too oriented to specifics of equipments, hardware and battlefield capabilities. Within the context of the JLRSS, JIEP and JSOP they have purpose and meaning; however, they do not meet the requirements for basic objectives upon which to build R&D strategies.

D. RDT&E Requirement Definition and Documentation System

As demonstrated in the discussion of the PPBS, each of the four Services has a family of plans which supports the joint planning process. The principal Service planning documents are listed in Table 3. These plans contribute to and culminate in the principal PPBS R&D objectives statement, the JRDOD, which has been discussed above. There is a separate RDT&E process in which the Services participate which, for lack of an approved or official term, will be entitled here an RDT&E Requirement Definition and Documentation System. The system both establishes and contributes to the establishment of R&D objectives in terms of operational capabilities. A recapitulation of the components of this system is provided in Table 5. As the Table indicates, the system functions differently within each Service. The principal significance of this system, which is conducted so formally within the Services yet so informally on a Departmental basis, is that it routinely generates the definition of both Service needs and objectives which are too specific and finite to serve as inputs to or models for this paper.

E. DDR&E Coordinating Papers

The third category of current R&D objectives is represented by three coordinating papers which are prepared under the aegis of ODDR&E--the Technology Coordinating Paper (TCP), the Area Coordinating Paper (ACP), and the

1. "Observations on the Planning of Research and Exploratory Development," op. cit., p. 14.

Table 5

OBJECTIVES IN THE RDT&E REQUIREMENT DEFINITION AND DOCUMENTATION SYSTEM

FUNCTION	SERVICE DOCUMENT[1]		
	ARMY	NAVY/MARINE CORPS	AIR FORCE
States a need for new or improved equipment.	Required Operational Capability (ROC) (Document may originate anywhere in the Army or from industry.)		
Describes an operational or support capability in the 10–20 year time frame which satisfies the ROC.	Operational Capabilities Objectives (OCO)	General Operational Requirements (GOR)	Required Operational Capability (ROC)
States the need for achieving a particular operational capability and outlines the characteristics necessary.		Tentative Specific Operational Requirement (TSOR)	
Outlines a technical approach to meet a stated need.	Qualitative Materiel Approach (QMA)	Proposed Technical Approaches (PTA)	
Outlines a requirement for an experimental development which is not yet assured as to military usefullness or technical or financial feasibility.	Advanced Development Objective (ADO)	Advanced Development Objective (ADO)	
Records approved OCOs, ROC's and other important materiel requirements documents.	Combat Development Objectives Guide (CDOG)		

[1] The listing is selective and does not include all such documents.

Table 5 (Continued)

OBJECTIVES IN THE RDT&E REQUIREMENT DEFINITION AND DOCUMENTATION SYSTEM

FUNCTION	SERVICE DOCUMENT		
	ARMY	NAVY/MARINE CORPS	AIR FORCE
States a need for a particular capability and outlines the system characteristics to be achieved.	Qualitative Materiel Requirement (QMR)	Specific Operational Requirement (SOR)	
Provides AMC approved R&D $\boxed{\text{Objectives}}$	Research $\boxed{\text{Objectives}}$ and Technology $\boxed{\text{Objectives}}$ (ROTO) (Army Materiel Commant)		
Directs and guides actions necessary to translate a ROC into an approved program.			Requirements Action Directive (RAD)

Mission Coordinating Paper (MCP). The TCP addresses a specifically defined area of technology, such as missile propulsion or medical and biomedical sciences. The ACP addresses specific mission areas such as land warfare or strategic defense. The MCP is to address specific mission areas over a broad area of development from the conceptual R&D stages through engineering, production and delivery to the operating forces. All three classes of papers are in evolution and are not fully implemented systems.

The concept of the TCP was approved in August of 1970. These papers were to:

- Identify the areas most in need of new technology to meet future military system requirements
- Outline the R&D programs planned by each Service to satisfy these requirements
- Provide priorities
- Reveal unnecessary duplication
- Inform managers what new technology to expect and when.[1]

TCPs are prepared in coordination with the Services, each of which provides:

- Objectives, problems whose solution would assist in attaining the objectives, and technological strategy for developing the Technology Base.
- Present state-of-art capabilities for each objective.
- Technical work planned for each objective.[2]

Originally it was planned that only 11 TCPs would be developed and that they would contain about 70 percent of the activities to develop the technological base.[3] During the 1973 hearings on the DOD appropriations for 1974, 12 TCPs were reported as being either completed or under development with more contemplated. The 12 TCPs listed were as follows:

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1 "Observations on the Planning of Research and Exploratory Development," op. cit., pp. 9-10 (4 October 1972).

2 RDT&E Management Guide, op. cit., pp. 2-18 & 2-19.

3 "Observations on the Planning of Research and Exploratory Development," op. cit., p. 10.

- Conventional Weapons
- Missile Propulsion
- Command Control and Target Acquisition Electronics (other than devices)
- Command Control and Target Acquisition Electronic Devices
- Aeronautical Vehicles
- Aircraft Propulsion
- Surface Vehicle Technology
- Medical and Biological Science
- Human Resources
- Materials and Resources (2 TCPs)
- Environmental Sciences[1]

The ACP is the principal DOD instrument designed to coordinate R&D programs by mission areas. There were originally 43 ACPs planned;[2] however, progress on these papers slowed with the advent of the MCP which may be duplicative.[3] The following are titles of several ACPs which have been are being developed (a full listing of current ACPs is contained in Appendix 6):

- Advanced Weapons[1]
- Environmental Quality[3]
- Medical Health Care[3]
- Undersea (Ocean) Surveillance

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[1] "Department of Defense Appropriations for 1974," Hearings before a Subcommittee of the Committee on Appropriations, House of Representatives, Ninety-Third Congress, First Session, Part 7, Research, Development, Test and Evaluation, p. 468 (17 September 1973). (Hereinafter referred to as "1974 Hearings").

[2] "Report of the Commission on Government Procurement," Volume 2, p. 105 (31 December 1972).

[3] Interview with Lt. Col. John J. McCambridge, ODDR&E (31 January 1974).

- Air to Ground Munitions
- Close Combat
- Air Superiority[1]

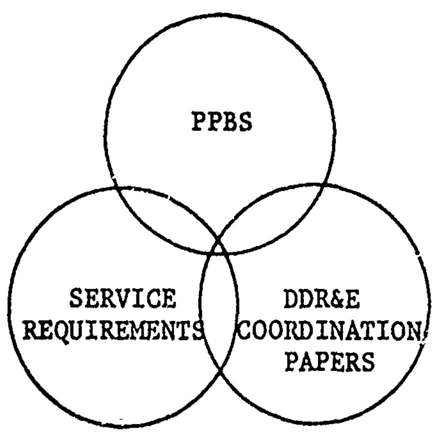
The MCP is in the experimental stage and is the latest development in this effort. The advent of the MCP and the temporary suspension of work on the ACPs indicate the informal nature of these coordinating instruments.[2]

F. Observations

The three systems described here--the PPBS, the RDT&E Requirement Definition and Documentation System, and the DDR&E Coordinating Papers--are separate and distinct. In terms of formal systems organization and cycle flow they each appear to be closed systems without interface or mutual support. However, it is sensed that there is in fact informal interface and informal communications between the systems which may be represented as demonstrated in Table 6.

Table 6

SYSTEM RELATIONS



1 "Fiscal Year 1973 Authorization for Military Procurement, Research and Development, Construction, Authorization for the Safeguard ABM, and Active Duty and Selected Reserve Strengths," Hearings before the Committee on Armed Services, United States Senate, Ninety-Second Congress, Second Session, Part 2 of 6 parts (15, 16, 17, 22, 23 and 24 February 1972). (Hereinafter referred to as "FY73 Authorization for Military Procurement.")

2 Interview with Lt. Col. John J. McCambridge, op. cit.

Of all the statements which have been described here, the JRDOD is the only document which purports to be devoted exclusively to the definition of R&D objectives. As stated earlier, however, the JRDOD is too detailed and too involved with the specifics of equipments, hardware and battlefield capabilities to serve as a model for objectives in this study. The scope of the ACPs, TCPs and MCPs appears to be more compatible with the requirements of this effort and, even though incomplete, may be the best reference point both for evaluating current objective definitions and for developing new ones for R&D within the Department of Defense.

III DESCRIPTION OF R&D OBJECTIVES

A. Overall Objectives

A review of the current literature on R&D reveals few clear statements of overall DOD R&D objectives. There are, however, many statements of goals, purpose, scope definition or function, each of which implies objectives. In Appendix 1 is an analysis of principal quotations, with their source, which were used for reference in the development of overall R&D objectives for this paper. The following objectives do reflect most of the consensus goals that are identified in Appendix 1; however, each statement is unique and ultimately represents the conviction of the author. The overall objective of:

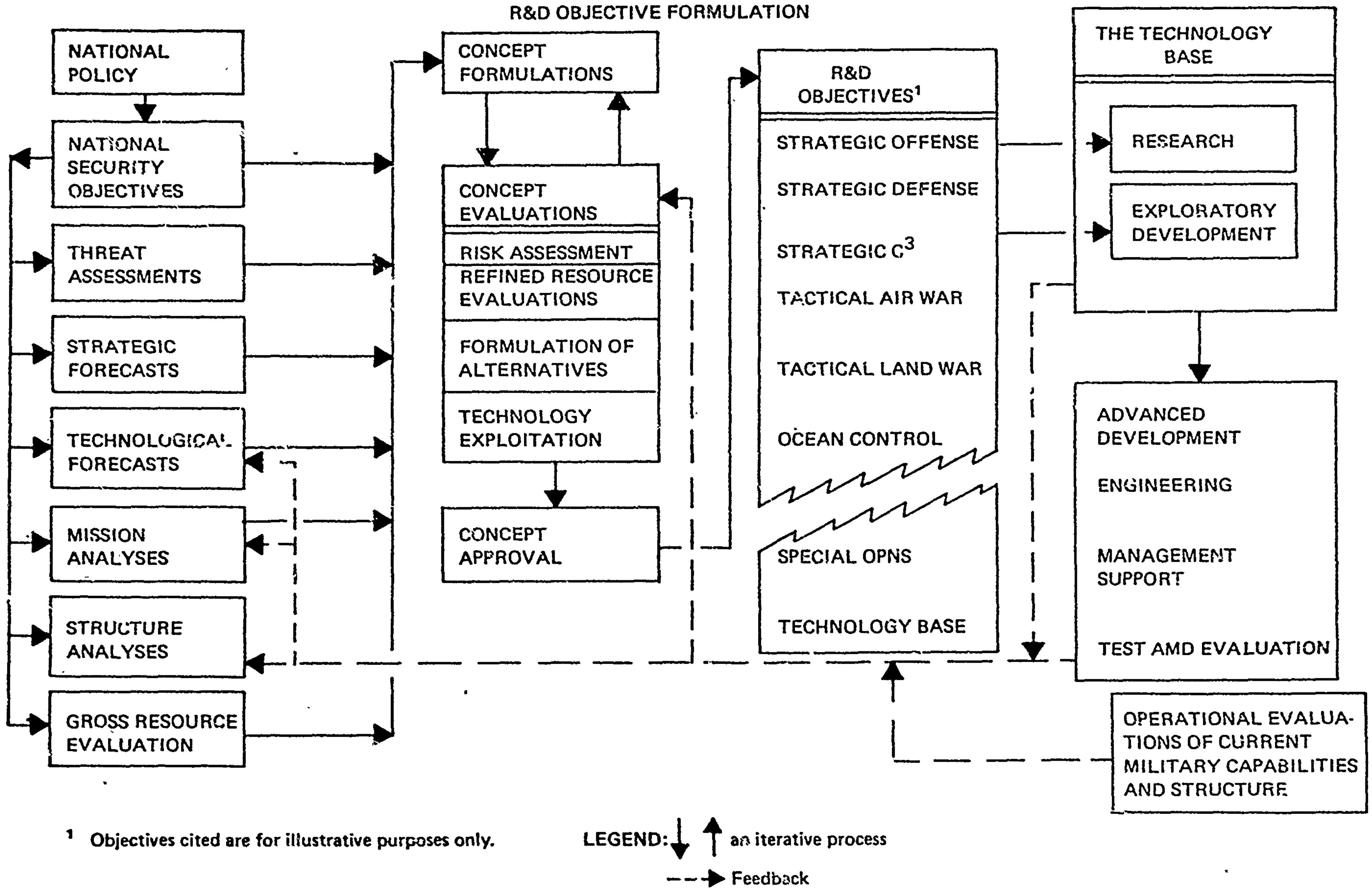
- Research is to solve problems and to discover and exploit new principles which lead to a better knowledge and understanding of phenomena within the physical, engineering, environmental, biomedical and behavioral sciences forecast in a long-range time frame.
- Exploratory development is to demonstrate the feasibility and applicability of allied research by solving problems associated with materials, processes and systems.
- Research and development is to improve operational capabilities and maximize assets through the advancement and exploitation of technology within the long-range time frame.

B. Detailed Objectives

A review of the literature on R&D failed to identify any officially endorsed categorization of R&D objectives. Table 7 presents a model for formulation of R&D objectives. The model is intended to have universal application for formulation of both macro category R&D objectives (e.g., strategic offense) and component micro objectives (e.g., a mobile land-based missile capability). The following are offered as the criteria for generating useful DOD R&D objectives at both macro and micro levels. These objectives should:

Table 7

R&D OBJECTIVE FORMULATION



[1] Objectives cited are for illustrative purposes only.

- Be based on stated national objectives, national and military strategy and guidelines of the National Command Authorities. As pointed out by Dr. John S. Foster, Jr.,[1] the objectives, guidelines, and strategies will not cover every contingency but they do provide the general guidance required within the DOD.

- Be based on an enlightened understanding of the capabilities of our current forces. Dr. Foster[1] would require that performance be evaluated on the basis of "conflict or in realistic operational tests" and that deficiencies be described "explicitly."[1] The approach implies both a "bottom up" as well as a "top down" flow of information.

- Be based on a thorough analysis of the international milieu projected into a long-range, twenty- to thirty-year time frame. The JLRSS and JIEP are designed to provide such projections. There are problems associated with each, however. The utility of both projections is restricted by their short, twenty-year time frames. (The JLRSS requires complete revision.) While the study has been revised annually, the basic structure is dated and of marginal utility for developing R&D objectives.[2] The critical requirements for long-term objectives in R&D have been argued by Seitz and Nichols:

> If each mission-agency were forced to narrow its R&D programs so that they fitted only the short-range definitions of a mission--as the Defense Department has been urged to do--the nation would soon have too little of the genuinely high-risk/high-gain R&D. We believe that defense R&D--like all of the other major mission-programs--should span a wide range, including selective investments in new high-potential technologies that do not necessarily meet a current, formally stated military requirement.[3]

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[1] "National Security Objectives... Weapons Systems We May Face--and Better Have," Army Research and Development News Magazine, p. 10 (March-April 1973).

[2] Steps were initiated by the JCS in 1973 to completely revise the JLRSS to provide a more current projection of strategy in the 20-year time frame.

[3] F. Seitz and R. W. Nichols, Research and Development and the Prospects for International Security, p. 35, National Strategy Information Center, Inc. (Crane Russak & Company, Inc., New York, 1973).

- Be based on current and projected fiscal realities. The current and short-range fiscal constraints on R&D within DOD are relatively simple to assess. The long-range predictions are much more difficult. A rule of thumb which would be useful in estimating fiscal constraints would be the FY1975 budget request $\pm$ 10 percent in terms of 1974 dollars. Economies in the R&D process are possible and research potential should be devoted to this purpose. However, while economy through R&D is an essential objective, it is too unpredictable to include as a factor in projection of long-range cost formulas.

- Be cast in terms of military missions in the context of new methods and increased efficiency or productivity. This approach parallels the FYDP military mission categories (strategic offense, strategic defense, etc.), the Area Coordinating Papers (ACPs), the Mission Coordinating Papers (MCPs), and the admonition of Dr. Foster that "DOD must manage a mission-oriented research base."[1] Dr. Malcom R. Currie, Director of Defense Research and Engineering, has stated relative to independent research and development: "Clearly it needs to be focused on the creation of technology directly applicable to future systems and on demonstrations that prove that new concepts are ready for application."[2] This approach to objective formulation emphasizes desired operational capabilities rather than technical potential. Nevertheless, it is still essential to incorporate both the information and innovations being generated in the technological base and the development of the base itself. (The categories of the DOD R&D program are cited in Appendix 2.) Nor should the orientation to military missions unduly constrain the research phase of the R&D cycle. Recognizing that objectives must be cast in terms of military missions, there nevertheless should be "no time scheduled benchmarks for development of solutions to immediate military problems."[3]

- Be based on a realistic assessment of the risks entailed in accomplishing the objective. Risk is defined as the "measure of the extent to which the various aspects of the

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[1] J. S. Foster, Jr., "The Defense Research and Technology Base," Defense Industry Bulletin, Vol. 5, No. 7, p. 2 (July 1969).

[2] M. R. Currie, "Defense R&D--Concerns and Opportunities," address given at the Sixth Biennial National Security Industrial Association Research and Development Symposium, Washington, D.C., 5 December 1973.

[3] R. P. Howell, A. Shapero, "The Structure and Dynamics of Research and Exploratory Development in Defense R&D Industry," Project No. IMU-4370, Stanford Research Institute, p. 1 (August 1966).

actual outcome of a development task can deviate from the results predicted for the task before its execution."[1] The requirements for a high probability of success and low risk increase with each step of the RDT&E cycle. At the research level a relatively high degree of risk should be accepted. In advanced development risk should be much lower. Risks are also more difficult to identify at the research and exploratory level of objective definition because such definitions must be cast in rather general terms.

- Be cast in qualitative, quantitative or relative terms whenever possible to provide a reference for the degree or value of the capability which is sought.
- Be based on the known and projected potentials of the technology base to include those available from allied sources.
- Be reasonably attainable within the time period specified.
- Be coordinated to ensure maximum transfer of operational utility, experience and technology among objectives.
- Be comprehensive and, within the projected capabilities of technology, address each of the identified requirements of the operating forces and potentials of the technology base.
- Be broad in the scope of each separate objective to permit flexibility, encourage serendipity, and limit objective variables to a manageable number. A proliferation of R&D objective statements would cause awkward administration and inefficient planning.[2]

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[1] C. L. Troyzo, "Description and Critique of Quantitative Methods for the Allocation of Exploratory Development Resources," p. 135, Institute for Defense Analyses (May 1972).

[2] Recommendations for defining objectives, mission areas and procedures may also be found in V. J. Bevinati, et al., "Quantitative Methods for the Allocation of DOD Exploratory Development Resources," pp. 41-44, Institute for Defense Analyses (May 1972).

- Give appropriate emphasis to basic research as the prime source for quantum improvements in capability.[1]
- Encourage and facilitate the transfer of technology among allies and between the DOD, other Governmental agencies and civilian sectors.
- Be supported by detailed rationale in terms of:
  - Interpretation of current policy
  - Threat
  - Long-range strategic analyses
  - Long-range technological analyses
  - Mission analyses
  - Force structure analyses
  - Current and projected resource availability
  - Risk assessment
  - Alternatives
  - Time phasing and requirements
  - Potential technological "spin-off"
  - Potential technological transfer from other jurisdictions.

Proposed R&D objective mission areas are displayed in Table 8. The first seven areas cited have been used in testimony before the Senate Armed Services Committee.[2] In contrast, and for comparison, the major FYDP programs are listed in Table 9.

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1 Dean A. V. Crewe has written in the Bulletin of Atomic Scientists, p. 2 (February 1974): "New ideas, good ideas, revolutionary ideas always come from people engaged in basic research... For instance, if, in 1939, the military requirement was for a very large bomb, the undoubted approach would have been to go to explosives experts and chemical companies and say 'build me a bomb, the bigger the better.' Those people might have come up with a 10- or 20-ton bomb. No one would have thought to take the project to a nuclear physicist involved in the basic research of the structure of the nucleus; yet that is precisely where the A-bomb came from. The idea for that was a matter of pure chance by people doing basic research, by people not at all interested in the production of a bomb. Nevertheless, the facts emerged that a bomb could be made, and the rest is history...

"Similarly, had we decided in 1955 to cure polio, the natural approach would have been to go to the medical community, and their natural reaction would have been to build thousands and thousands of iron lungs. But the solution to that problem came from people who were building on a strong foundation of basic research on the nature of viruses."

2 "FY73 Authorization for Military Procurement," op. cit., pp. 749-753.

Table 8

R&D OBJECTIVE MISSION AREAS

- Strategic Offense
- Strategic Defense
- Command, Control and Communications
- Tactical Air Warfare
- Tactical Land Warfare
- Naval Warfare
- Mobility
- Intelligence
- Special Operations
- Technology Base
- Administration

Table 9

FYDP PROGRAM CATEGORIES

I	Strategic Forces
II	General Purpose Forces
III	Intelligence and Communications
IV	Airlift and Sealift
V	Reserve and Guard Forces
VI	Research and Development
VII	Central Supply and Maintenance
VIII	Training, Medical and Other General Purpose Activities
IX	Administration and Associated Activities
X	Support of Other Nations

Categories and disciplines of the DOD R&D program (e.g., general physics, oceanography, etc.) are listed in Appendix 2. ODDR&E technology coordinating paper (TCP) category areas are listed in Appendix 3. Candidate R&D major components of the objective mission areas in Table 8 are listed in Appendix 4. An outline of an R&D objective statement appears in Appendix 5.

C. An Illustrative R&D Major Category Objective

The following statement of an R&D major category objective provides an example of the format, scope, and content believed to be required. It is illustrative only and does not meet the requirements cited in this paper that objectives be based on thorough policy, capability, threat, risk and technological analyses.

1. Naval Warfare--Definition

Naval warfare, within the context of this R&D objective, includes naval operations for ocean control, projection of power ashore and overseas presence. Ocean control is the employment of naval forces, supported by land and air forces, as appropriate, to achieve military objectives in vital sea areas. Such operations include destruction of enemy naval forces, suppression of enemy sea commerce, protection of vital sea lanes, and establishment of local military superiority in areas of naval operations.[1] Projection of power is accomplished primarily by amphibious forces and carrier aviation and extends naval operations from the sea to and across the littoral in areas controlled or threatened by enemy forces.[2] Overseas presence is the deployment of naval forces to vital sea and coastal areas to influence, protect or to demonstrate resolve in furtherance of U.S. objectives.

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[1] The term "ocean control" (which is used in Congressional Hearings on R&D), is considered to be synonymous with "sea control." The definition provided here is almost verbatim from the JCS Pub. 1, Dictionary of Military and Associated Terms, p. 266 (3 January 1972) definition of sea control operations. (Hereinafter referred to as JCS Pub. 1).

[2] Paraphrase of "land, sea, or aerospace projection operations," ibid., p. 172.

2. Description of Mission Area

a. Current Characteristics

This mission area includes surface, subsurface and naval air operations. It includes projection of naval power ashore both air and landing force. It does not include strategic offensive or defensive nuclear operations or any other aspect of naval warfare which is included in another major R&D category.

There are currently 221 major combat surface ships and 84 attack submarines active in the U.S. Navy, including 15 attack carriers and 60 nuclear submarines.[1,2] Amphibious forces include 3 marine divisions and 3 marine air wings (196,000 personnel)[1] and 71 amphibious warfare ships.[3] Both the size and the overall capability of the U.S. Navy and Marine Corps have declined since the end of the Vietnam War.[4] In early 1974 the Chief of Naval Operations reported to Congress: "We stand now at our point of greatest weakness and in my estimate in our greatest jeopardy."[5] Nevertheless, there has been a concerted program of modernization, research and development in the naval service. The FY74 defense budget requested $3.9 billion for modernization and acquisition of ships which constituted a 30 percent increase over the previous year. The Navy allocation for 1974 was the largest of all the Services.[6] The post-Vietnam decline will begin to reverse itself in 1974 when the drop from 976 ships in 1968 to 508 will be

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[1] The Military Balance 1973-74, pp. 3-4 (The International Institute for Strategic Studies, London, September 1973).

[2] By the end of FY74 the active fleet will include 62 nuclear and 12 diesel powered attack submarines as reported by Secretary of Defense Elliot R. Richardson, "Statement Before the House Armed Services Committee on the FY74 Defense Budget and FY74-78 Program," p. 13 (10 April 1973).

[3] Jane's Fighting Ships 1972-73, p. 391 (McGraw-Hill Company of Canada).

[4] Ibid., p. 77.

[5] Admiral Elmo R. Zumwalt in testimony before the Senate Armed Services Committee, 19 February 1974, as reported in Washington Post, p. A-3 (20 February 1974). (Hereinafter referred to as Zumwalt 19 February 1974 Testimony.)

[6] M. T. Klare, "After Vietnam, Defense Puts Out to Sea," The Nation, p. 10 (2 July 1973). (Hereinafter referred to as "After Vietnam.")

stopped with the introduction of modern ships in the fleet.[1] The Chief of Naval Operations has consistently emphasized the significant and singular application naval power has in the execution of the Nixon Doctrine.[2] He has suggested that, due to geopolitical considerations, Navy and Marine Corps forces "may be the only forces which have utility" in future military operations.[3] The following represents the investment made in the Navy program to buy new ships and ready them for sea:

FY 1968 - $1.5 billion
FY 1972 - 3.0 billion
FY 1973 - 3.2 billion
FY 1974 - 4.0 billion[4]

b. Direction of Current R&D Efforts

More so than in the other military departments, the Department of the Navy R&D efforts are justified by, focused on and structured for meeting the explicit threat of the Soviet Union's force posture. As much as any other Service Department, the Navy emphasizes that its RDT&E program relies upon the maintenance of a sophisticated technology base.[5] Examples of the contributions made by naval scientists in the technology base range from work on solar magnetic fields,[6] high-temperature materials and composite structures for re-entry vehicles,[7] freeze-dried[8] and synthetic skin

1 Zumwalt 19 February 1974 Testimony, op. cit.

2 For example see: Statement of Admiral Elmo R. Zumwalt, Jr., U.S. Navy before the Committee on Appropriations, Subcommittee on Department of Defense, United States Senate, concerning FY72 Military Posture and Budget of the United States Navy.

3 M. T. Klare, "After Vietnam," op. cit., p. 10.

4 O. Kelly, The Sunday Star and Daily News, p. E-2 (8 July 1973).

5 Senate Hearings Before the Committee on Appropriations, 92nd Congress, Second Session, FY 1973, Part 3, Department of the Navy, p. 1411. (Hereinafter referred to as FY73 Senate Hearings).

6 Naval Research Review, p. 16 (August 1973).

7 FY73 Senate Hearings, op. cit., p. 1412.

8 Naval Research Review, p. 27 (October 1973).

grafts,[1] and a flexible skin variable camber wing for improved capabilities in maneuvering, buffet margins, effective cruise speeds and low altitude penetration.[2] In 1973 the Assistant Secretary of the Navy, Dr. Robert A. Frosch, evaluated the importance of these programs as follows: "... taken in sum, they form a base without which the Navy (new or old) simply could not continue to operate effectively."[3]

In naval platforms and weapon systems eighty-knot, 100-ton surface effect test ships are in the test phase of the cycle.[4] The sea control ship, patrol frigate, modern carrier escorts (DD 963), patrol hydrofoil (PHM), an official NATO project with the Federal Republic of Germany and Italy, are all in advanced stages of development or testing.[5] The surface effect ship program is designed to support the production of a 2,000-ton ship with an open ocean capability "by the end of this decade."[6] In terms of weapons, the Navy has the Harpoon missile capable of air and surface launch, the air to surface dual mode TV and radar seeking missile, the Condor,[7] the MK 48 torpedo[8] and the close in weapons system (CIWS) in late stages of development. In Table 10 is a digest of FY74 RDT&E major weapon programs requests the President sent to Congress on 29 January 1973.

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1 Naval Research Review, p. 32 (September 1973).

2 Ibid., p. 11 (June 1973).

3 FY73 Senate Hearings, op. cit., p. 1413.

4 Ibid.

5 "Fiscal Year 1974 Authorization for Military Procurement, Research and Development, Construction Authorization for the Safeguard ABM, and Active Duty and Selected Reserve Strengths," Hearings before the Committee on Armed Services, United States Senate, Ninety-Third Congress, First Session, Part 2, Authorizations, pp. 598-599 (10 April-1 May 1973).

6 Ibid., pp. 798-799.

7 Ibid., pp. 844-846.

8 FY73 Senate Hearings, op. cit., p. 1416.

Table 10

MAJOR NAVY/MARINE CORPS WEAPONS PROGRAMS[1]

	Quantity	Amounts (Million $) Procurement*	RDT&E	Description
AIRCRAFT				
A-6E Intruder	15	$ 138.6	$10.0	Navy/Marine long-range jet attack aircraft capable of delivering nuclear or conventional ordnance under all weather conditions.
EA-6B Prowler	6	134.9	4.0	Derivative of A-6 attack aircraft capable of degrading enemy radar and communication lines.
A-7E Corsair II	42	185.0	5.1	Jet attack aricraft providing extreme accuracy and high payload in support of close tactical support and interdiction missions.
F-14A Torncat	58	575.4	40.4	Carrier-based supersonic jet fighter capable of air-to-air and air-to-surface attack missions.
S-3A Viking	45	541.1	5.2	All-weather, long-range land/carrier-based ASW aircraft.
E-2C Hawkeye	9	164.0	1.4	Turbo-prop, carrier-based early warning aircraft.
MISSILES				
Sparrow AIM-7E/F	–	91.3	7.4	Navy/Air Force semi-active radar-guided air-to-air missile.
Phoenix AIM-54A	–	96.2	4.1	Supersonic, all-weather, long-range air-to-air missile.

*Includes initial spares, military construction funds, etc., where provided.

[1] Extracted from Sea Power, p. 12 (March 1973).

Table 10 (Continued)

MAJOR NAVY/MARINE CORPS WEAPONS PROGRAMS

	Quantity	Amounts (Million $) Procurement	RDT&E	Description
MISSILES (continued)				
Condor AGM-53A	–	23.2	8.3	Electro-optical-guided, medium-range, supersonic cruise missile.
Harpoon	–	19.0	66.6	Ship/air-launched anti-ship missile.
Standard-SSM	–	8.6	12.0	Surface-to-surface missile.
SHIPS				
PHM	–	3.9	24.0	Patrol hydrofoil missile ship for surveillance and blockade.
MISCELLANEOUS				
Close-In Weapons System (CIWS)	–	13.0	4.8	Unitized gun weapon system of 20mm size providing defense against the anti-ship missile threat and low-flying aircraft.
Mk48 Torpedo	–	182.9	8.3	Conventional (nonnuclear) torpedo.
Captor	–	11.6	13.2	Encapsulated torpedo to destroy enemy submarines.
CH-53E	–	–	30.0	Shipboard-compatible lift helicopter designed to handle loads up to 16 tons.
Surface Effect Ship (SES)	–	–	72.8	High-speed transoceanic ship supported on a cushion of air.

Table 11

RELATIVE NAVAL FORCE STRENGTHS--1973

Surface Combatants	U.S.	USSR
Aircraft Carriers	16	0
Helicopter Carriers	7	2
Cruisers	9	25
Destroyers and Destroyer Escorts	211	204
Total	243	231

Sub Surface Combatants	U.S.	USSR
Nuclear	56	65
Diesel	41	218
Total	97	283

Source: "The Balance of Power," Boston Globe, p. 12 (11 November 1973).

3. Threat Peculiar to Mission Area

In no other area of threat assessment in the past ten years has there been such a dramatic increase in Soviet capability as in the USSR fleet. The Mediterranean has been the focus of Soviet strategic expansion where their fleet numbered about twenty-five vessels in 1966. In eight years it has doubled and has sometimes grown to seventy ships, half of which are combatants.[1] Overall, the Soviets increased the number of their ships by 7 percent between 1962 and 1972.[2] However, comparisons of the relative effectiveness of the U.S. and Soviet navies or NATO and the Warsaw Pact are difficult to judge. There are areas (naval aviation, for example[3]) where the United States and its NATO allies have a distinct advantage over the Pact forces.[4] Capitalizing on such potentials, however, depends upon the duration and type of war which may be fought. Numbers of combatant vessels in specific areas of operations may be misleading for, after all, naval forces are characterized by mobility, and what may be a numerical and combat-effective superiority on one day could become a serious combat deficiency the next. The comparative statistics in Table 11 are presented with these reservations in mind. The significant aspect of the Soviet naval threat seems to be that the USSR has seriously challenged U.S. dominance in critical areas of naval operations and enjoys the initiative in its drive for naval ascendancy. Secretary of Defense Schlesinger has characterized the Soviet Navy as "blue water" and Admiral Zumwalt has termed the Russian anti-ship missile capability as one of the "greatest challenges to fleet defense which we have ever faced."[5] Norman Polmar, editor of the

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[1] "Soviet Ambitions in the Mideast," The Alternative Magazine, p. 10 (January 1974).

[2] FY73 Senate Hearings, op. cit., p. 24.

[3] Jane's Fighting Ships 1972-73 states that there are consistent reports circulating that the USSR is constructing its first aircraft carrier, a 30,000-ton-displacement, 800-foot vessel, the Kiev.

[4] In testimony before the Senate Armed Services Committee Secretary of Defense James R. Schlesinger has stated "I do not subscribe to alarmist statements alleging the current superiority of the Soviet fleet. There are circumstances and there are places where the U.S. Navy cannot go today with a high confidence of success. But I think this was built into the cards. We continue to have some edge in naval capability." As reported in Washington Post, p. A-3 (20 February 1974).

[5] Zumwalt 19 February 1974 Testimony, op. cit.

United States section of Jane's Fighting Ships, has written:

> The U.S. margin of relative superiority in numbers alone ... is now rather tenuous, although the U.S. Navy remains well ahead in overall combat capabilities (in the most probable scenarios).
>
> It also seems clear that the Soviet Navy has optimized its forces specifically against the most significant U.S. capability, the attack carrier and accompanying air groups and has developed tactics to match, for which reason there can be no assured outcome to an engagement fought on Soviet terms. This was not the case a decade ago.[1]

A careful look at the development of the growth of Soviet naval forces since 1962 appears to lend substance to the claim that their fleet is tailored to combat or neutralize the U.S. and NATO ally fleets or, as Laurence W. Martin has written, "Looked at in strictly naval terms, the Soviet navy is a force designed to deny the seas to a more powerful force. For this reason it is not technically an ideal force to undertake interventions."[2] The Chief of Naval Operations has countered, however, that the Soviets may very well be building a capability for intervention overseas.[3]

4. Policy Implications Applicable to Mission Area

The principal policy instruments and initiatives particularly applicable to naval warfare[4] are the:

- Seabed Arms Control Treaty which entered into force 18 May 1972 and which, inter alia, provides that the states which are parties to the Treaty agree not to emplant or emplace on the seabed any mass destruction weapon.[4]

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1 N. Polmar, "The Navy and the Nation: Approaching the 'Final Sands?'" Sea Power Magazine (October 1973).

2 L. W. Martin, "Military Issues: Strategic Parity and Its Implications," in Retreat From Empire?, R. E. Osgood, ed., p. 156 (Baltimore: Johns Hopkins University Press, 1973).

3 Zumwalt 19 February 1974 Testimony, op. cit.

4 "Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Seabed and the Ocean Floor and in the Subsoil Thereof," Article I (11 February 1971).

- Law of the Sea Conference called for by a resolution of the United Nations General Assembly which has been categorized by the President as being "essential." The United States has presented the following draft treaty articles to the U.N. Seabed Committee:

  "--a territorial sea with a maximum breadth of 12 nautical miles, together with and conditional on
  "--a right of free transit through and over straits used for international navigation."[1]

- Maintenance of the capability to keep open vital maritime lines of communication[2] which is basic to the NATO strategic concept for defense.

- Total force concept[3] which requires planning based on the premise of the support of our allies and of our own Naval Reserves.

- All-volunteer force and the associated policies for achieving force objectives at quality standards.[4]

- Effective use of managerial resource programs particularly in weapons acquisition programs.[5]

- MPFR and CSCE which to date have not but could have naval force implications.[6]

- Forward deployment of naval forces where U.S. vital interests and the threat require same.[7]

- Nixon Doctrine itself which some interpret as a foreign policy which promotes and requires a strong naval capability.[8]

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1 R. M. Nixon, "U.S. Foreign Policy for the 1970s: Shaping a Durable Peace," Vol. IV, p. 217, Report to the Congress (3 May 1973).

2 "FY74 Annual Defense Department Report," by Secretary of Defense Elliot L. Richardson, p. 26 (29 March 1973).

3 Ibid., p. 5.

4 Ibid., p. 15.

5 Ibid., pp. 16-17.

6 Ibid., p. 23.

7 Ibid., p. 28.

8 For example, see L. W. Martin, op. cit., p. 176.

5. Constraints Peculiar to Mission Area

The principal constraints peculiar to naval warfare include the following:[1]

- The Seabed Arms Control Treaty cited in paragraph 4 above.
- High developmental costs of naval systems such as the CVN 70, nuclear submarines and naval aviation.
- Requirements for commonality of communication and certain ship characteristics between allies in combined fleets (a reflection of total force concept).
- The wide range and varied conditions of U.S. naval interests from the Indian Ocean to the Atlantic, from the Arctic to the Southeast Pacific Basin, from the reaches of space to the abyssal depths to extension of operations ashore.
- The difficulty of relating naval technology to naval strategy.[2]
- The growth and technological advances of the Soviet fleet.
- Cost of some new naval systems (e.g., CVNs) is so high that they must be planned for retention in active service through their period of anticipated obsolescence.[3]
- Current reliance of fleet upon overseas bases and support installations.
- Shipboard habitability on extended deployments.
- The history of naval contractor overruns.
- The decline of the U.S. Merchant Marine.

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[1] This paragraph is limited to those considerations which primarily impact on naval warfare. There are many other constraints (e.g., SALT pacts, Test Ban Treaties, etc.) which impact on other mission areas as well but which are not cited here.

[2] Although the Navy has made a conscious effort to make such an association. See S. T. Possony and J. E. Pournelle, The Strategy of Technology, Winning the Decisive War, p. 13.

[3] For a discussion of this constraint see the Secretary of the Navy comments to the Senate Armed Services Committee in FY73 Senate Hearings, op. cit., p. 54.

6. Objective Elements

Capitalizing on current and anticipated technology, the R&D objective for naval warfare is to define, exploit, and develop principles, techniques, materials and systems which will insure U.S. capability to defeat or neutralize enemy naval forces, suppress enemy sea commerce, control vital sea lanes, and gain and maintain superiority in vital ocean and ocean contiguous areas of naval operations:[1]

- For the mid range, emphasizing modification adaptation and innovation.
- For the long range, emphasizing new concepts, approaches and technology.[2]

Priority effort should be devoted to:

- Development of maritime policy, strategy and tactics which support national policy, reflect the international milieu and are fully integrated into the overall defense.
- Ubiquity of naval presence based on high order of naval platform mobility/speed (100 knots), endurance and independence from shore-based support facilities as contrasted to presence which relies on numbers of redundant forces.
- Offensive naval platforms which are defensively self-sufficient, which are free from requirements of augmentation for providing requisite mobile protective envelopes.

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[1] For the purpose of this objective statement, naval operations are defined as exclusive of strategic operations involving the delivery of nuclear weapons and other R&D major category objective areas listed here. JCS Pub. 1 (3 January 1972) defines a naval operation as: "A naval action, or the performance of a naval mission, which may be strategic, tactical, logistic, or training; the process of carrying on or training for naval combat to gain the objectives of any battle or campaign."

[2] The short-range period--0-2 years--is not included as a target objective because of the minimum impact R&D may have in such a short time frame. The mid-range is defined as 2-10 years. The long-range is defined as 10-30 years.

- Projection of power ashore by amphibian platforms, air and amphibious landing forces from widely dispersed operating areas deep in the sea echelon to areas contiguous to the sea.
- Integrated, all-condition ocean surveillance system for all critical ocean areas above surface, surface and sub surface.
- Extended range (in excess of hostile acquisition ranges), reliable target acquisition and retention system coupled with highly accurate, discriminating, one-target, one-shot, one-hit weapon system capability.
- Control of deep ocean areas to include the territorial limits of the continental shelf to which the United States lays claim and guaranteed access to the abyssal plains for defense and economic development.
- Weather and climate modification in, on and over the seas.
- Secure, reliable, large capacity, world-wide naval command, control and communication system integrated with that of allied forces.
- Self-contained, large-capacity ocean transport, air, surface or sub surface, immune from interdiction and free of requirements for convoy or augmentation for security.
- Naval strategy and tactics to maximize efficiency of forces against projected threats to include immediately responsive moving zone offensives against hostile naval forces and mobile full envelope defenses for friendly naval forces.

APPENDIX 1

APPENDIX 1

STATEMENTS OF OVERALL R&D OBJECTIVES

A review of the current literature on R&D reveals few clear statements of DOD R&D objectives. However, there are many statements of goals, purpose, scope, definition, or function, which imply objectives. The following are the principal quotations, with their source, which were used to develop the overall R&D objective stated in the basic paper. (Underscoring has been added by the author and is keyed to the Table 1 matrix "Components of RDT&E Objectives".)

Quote 1

In summary, then, the three parts of our research and technology effort are as follows:

Research--the search for new principles that lead to potential capabilities different in kind from anything previously known (funded in the 6.1 budget category).

Exploratory development--the development of materials and processes and the invention of components and subsystems to enable new concepts to be applied (funded under the 6.2 budget category).

Advanced development--the proof that components and subsystems will actually work in the "real world" (funded under the 6.3 budget category).

Source: Fiscal Year 1973 Authorization for Military Procurement Research and Development, Construction Authorization for the Safeguard ABM, and Active Duty and Selected Reserve Strengths, Hearings before the Committee on Armed Services, United States Senate, Ninety-Second Congress, Second Session, Part 2 of 6 parts, p. 784 (February 15, 16, 17, 22, 23, 24, 1972).

Quote 2

Returning to our detailed assessment, then, the Department of Defense "buys" with its $1-billion technology base expenditure, four principal items:

- A capability to solve, by technical means and on a short time scale, urgent problems encountered by our armed forces.

- A capability to evaluate new defense concepts and to select those of greatest potential value.
- A capability to advance technology across a broad front of military need.
- A capability to provide improvements in the operations of our armed forces that save money or increase personnel effectiveness.

Source: Ibid., p. 789.

Quote 3

The goals of research and exploratory development must be formulated from two perspectives: long-term gain, consistent with the nature and direction of scientific technological progress; and shorter-term matters of concern to our national security.

For the long term, we seek to probe the frontiers of defense-relevant science and engineering, to discover and understand new phenomena, to recognize and exploit those which have promise for improved military technology.

Source: John S. Foster, Jr., "The Defense Research and Technology Base," Defense Industry Bulletin, Vol. 5, No. 7, (July 1969).

Quote 4

Within the broad goals of our research and technology base, the research component works at the frontiers of knowledge in the physical, engineering, environmental, biomedical, and behavioral sciences, emphasizing fundamental work relevant to long-range defense needs.

Source: Ibid., p. 2.

Quote 5

The purpose of exploratory development is to demonstrate the feasibility and applicability of research discoveries to DOD needs. It is also the mechanism we use to ensure that each technological opportunity has a matching military utility, and that feasibility determinations are made in full realization of the anticipated use of the device or component.

Source: Ibid., p. 4.

Quote 6

Research--This new category includes both basic and applied research directed toward the expansion of knowledge in such fields as the physical and environmental sciences, mathematics, psychology, sociology, biology and medical sciences, as well as "in-house" laboratory independent research.

Source: Statement of Secretary of Defense Robert S. McNamara Before the House Armed Services Committee, the Fiscal Year 1964-68 Defense Program and 1964 Defense Budget, p. 95 (30 January 1963).

Quote 7

Exploratory Developments--This category consists of activities directed toward the solution of specific military problems short of the development of hardware for experimental or operational testing, and varies from fairly fundamental efforts to sophisticated breadboard hardware, study, programming and planning.

Source: Ibid.

Quote 8

Thus, in the first two phases, Research and Exploratory Development, we do not as a general rule attempt to prescribe goals, milestones and time schedules. Projects included in these categories are usually controlled on a "level of effort" basis.

Source: Statement of Secretary of Defense Robert S. McNamara Before the House Armed Services Committee, the Fiscal Year 1965-69 Defense Program and 1965 Defense Budget, p. 100.

Quote 9

Research--(DOD, IADB) All effort directed toward increased knowledge of natural phenomena and environment and toward the solution of problems in all fields of science. This includes basic and applied research.

Source: JCS Pub. 1, Department of Defense Dictionary of Military and Associated Terms, Joint Chiefs of Staff, Washington, D.C., p. 256 (3 January 1972).

Quote 10

The technology base is the total reservoir of organized knowledge from directly and indirectly sponsored basic research into physical and social phenomena and the feasibility of new processes, techniques, and components for using them. Its end result is new organized knowledge. The base also retains fallout contributions left over from the exploration and development of specific systems. The creation and exploration of candidate systems, in turn, is shaped by the information available from the technology base.

Source: Report of the Commission on Government Procurement, Vol. 2, p. 114 (31 December 1972).

Quote 11

The purpose of research is to increase our basic understanding of natural phenomena from which new ideas for military hardware may be generated. The purpose of exploratory development is to determine the feasibility of utilizing this basic understanding to solve specific military problems; broadly stated, its end product is the determination of the feasibility of concepts and the understanding of engineering characteristics to intelligently decide whether to proceed with developing the military hardware or processes.

Source: Observation on the Planning of Research and Exploratory Development, Department of Defense, (B-164912), U.S. General Accounting Office, p. 2 (4 October 1972).

Quote 12

The ultimate objective of Army research and development is to develop weapons, systems and equipment, to be used primarily by the Army, that can be effectively manned and supported, and that have superior performance to those employed by a potential enemy--regardless of the operational environment and conditions of war.

Source: FM 37-80 Research, Development, Test and Evaluation Management, Headquarters, Department of the Army, p. 5-7 (August 1973).

Quote 13

The Army's principal objective during research and exploratory development is to maintain a strong, viable, and progressive technological base.

Source: Ibid.

Quote 14

It is not uncommon for people to equate "RDT&E" with the development of hardware, a view which is as limited as it is erroneous. The "product" or "output" which justifies RDT&E effort is an operational capability. Weapons hardware is but one "subsystem" of the "operational capability system." This point must be reemphasized: The objective of RDT&E is operational capability, not hardware per se.

Source: Department of the Navy RDT&E Management Guide, Part I: System Description, NAVSO P-2457, p. 2-6 (Rev. July 1972).

Quote 15

The function of RDT&E in the development of operational capabilities is the production of the knowledge required to achieve such capabilities. Some needed capabilities do not require new knowledge for their attainment, hence are not RDT&E problems.

Source: Ibid.

Quote 16

The R&D program is dedicated to placing the appropriate weapons and equipment in the hands of operational and support forces. This objective dictates steady and unfailing advances in technology to overcome obvious, near-term deficiencies and to support developments to meet the foreseeable needs of the future.

Source: Defense Research and Development, Industrial College of the Armed Forces, Washington, D.C. p. 5 (1968).

Quote 17

The purpose of RDT&E is to provide scientific and technological capabilities for the development, test, and improvement of advanced weapon systems and related equipment and techniques. Many investigative and engineering activities are performed, including scientific research directly related to defense functions and operations, design and fabrication of weapons and equipment for the future, and testing of these items to evaluate their military utility.

Source: Federal Funding and National Priorities, An Analysis of Programs, Expenditures and Research and Development, Leonard Sederman and Margaret Windus, p. 42 (Praeger, New York, 1971).

Quote 18

The central point of our recommendations is a greater emphasis on research and development activity aimed at the discovery and utilization of new ideas, a lesser one on the procurement of new weapons systems as integrated packages. This, in turn, means more separation between research and development activities and production and a great increase in the proportion of the research and development effort not tied directly to a particular procurement program.

Source: Defense, Science and Public Policy, Edwin Mansfield, p. 114 (Norton and Company, New York).

APPENDIX I

Table A–1

COMPONENTS OF OVERALL RDT&E OBJECTIVES EXTRACTED FROM SELECTED STATEMENTS

FUNCTIONAL AREA	ELEMENTS OF OVERALL OBJECTIVES												
	Search for new principles that lead to new capabilities	Development of new materials and processes and invention of components and subsystems	Solve problems (short of development of hardware)	Evaluate concepts	Advance technology	Improve operational capabilities	Discover, understand and exploit new phenomena	Project over long range time frame	Physical, engineering, environmental, biomedical and behavioral sciences	Knowledge	Demonstrate feasibility and applicability of research	Develop weapons systems and equipment and techniques	Save money
RDT&E						14,15				15		17	
R&D (Technology Base)			2	2	2,13 16	2	3,18	3	10	10			2
RESEARCH	1		9				3,9,11	4	4,6,9	4,6,9			
DEVELOPMENT		1	7,11								5,11		

LEGEND: Numbers in matrix refer to quotations cited in Appendix.

APPENDIX 2

APPENDIX 2

CATEGORIES AND DISCIPLINES OF THE DOD R&D PROGRAM[1]

- General Physics
- Nuclear Physics (Navy and Army Only)
- Chemistry
- Mathematical Sciences
- Missiles (Army Only)
- Electronics
- Materials
- Mechanics
- Energy Conversion
- Oceanography (Navy)
- Territorial Sciences
- Atmospheric Sciences
- Astronomy and Astrophysics
- Biological and Medical Sciences
- Behavioral and Social Sciences

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[1] From: "Observation On the Planning of Research and Exploratory Development," Department of Defense, B-164912, U.S. General Accounting Office (4 October 1972).

APPENDIX 3

APPENDIX 3

ODDR&E TECHNOLOGY COORDINATING PAPERS CATEGORY AREAS[1]

- Detection and Location
- Guidance and Control
- Navigation
- Communications
- Automatic Data Processing
- Electronic Countermeasures
- Aircraft Engine Technology
- Rocket Engine Technology
- Surface and Underwater Vehicle Propulsion
- Aeronautical Vehicle Technology
- Chemical Warfare
- Biological Research
- Munitions Technology
- Nuclear Technology
- Electronic Device Technology
- Materials Technology
- Environmental Sciences
- Medical and Life Sciences
- Human Resources

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1 As of 1972 and reported in V. J. Berinati, et al., "Quantitative Methods for the Allocation of DOD Exploratory Development Resources," p. 113, Institute for Defense Analyses (May 1972).

APPENDIX 4

APPENDIX 4

CANDIDATE R&D MAJOR COMPONENTS OF OBJECTIVE MISSION AREAS[1]

Objective Mission Area	Components
Strategic Offense	1. Missile Systems • Land Based - Fixed - Mobile • Sea Based • Air Borne 2. Strategic Aircraft • Piloted • Remotely Piloted • Decoy 3. Defense Suppression 4. Electronic and Counter Electronic Warfare 5. New Systems and Concepts
Strategic Defense	1. Area 2. Site 3. Strategic Surveillance and Early Warning Systems 4. Electronic and Counter Electronic Warfare 5. New Systems and Concepts
Command, Control and Communications	1. Command • Facilities • Organization • Authorities • Procedures 2. Control • Procedures • Warning

[1] The component listing is not intended to be exclusive but demonstrative.

Objective Mission Area	Components
Command, Control and Communications (Continued)	3. Communications • Facilities • Equipment • Procedures • Warning
Tactical Air Warfare	1. Air Superiority • Counter Air Operations/ Antiair Warfare 2. Reconnaissance and Surveillance 3. Deep Strike/Interdiction 4. Defense Suppression 5. Close Air Support 6. Electronic and Counter Electronic Warfare 7. Navigation and Navigation Aids 8. New Systems and Concepts
Tactical Land Warfare[1]	1. Infantry Operations 2. Tactical Nuclear Operations 3. Armor and Anti-Armor Operations 4. Field Artillery Operations 5. Arimobile and Airborne Operations 6. Engineer Operations 7. Air Defense Operations 8. Diversive Operations 9. Nuclear Operations 10. Chemical, Biological and Radiological Operations 11. Electronic and Counter Electronic Warfare 12. New Systems and Concepts

[1] Categories are partially extracted from "Combat Development Objectives Guide (CDOG)," No. 11-25, Vol. 2, p. 103, October 1968, as reported in Report of the Commission on Government Procurement (December 1972).

Objective Mission Area	Components
Naval Warfare	1. Ocean Surveillance • Undersea • Surface
	2. Fleet and Ocean Area Defense • ASW • Antiair - Surface - Aerial
	3. Amphibious Operations • Assault • Other
	4. Surface Attack
	5. Subsurface Attack
	6. Electronic and Counter Electronic Warfare
	7. Navigation and Navigation Aids
	8. Oceanography
	9. Mining and Mine Countermeasures
	10. New Systems and Concepts
Mobility	1. Airlift • Strategic • Tactical
	2. Surface • Land • Sea - Surface - Subsurface
	3. New Systems and Concepts
Intelligence	1. Technology Assessment • U.S. • USSR • Other • Syntheses
	2. Intelligence Systems • Strategic • Combat • Target • Technical • Counterintelligence

Objective Mission Area	Components
Intelligence (Continued)	3. Cryptographic Security 4. New Systems and Concepts
Special Operations	1. Psychological Operations 2. Unconventional Warfare 3. Internal Defense and Development 4. Civil Affairs 5. Satellite, Space Operations and Astronautics 6. Environmental Systems 7. Support to Other Nations 8. Research, Development, Test and Evaluation 9. Asset Control and Economies 10. Guard and Reserve Forces 11. Security 12. Weather 13. New Systems and Concepts 14. Internal Security
Technology Base	1. The technology base is too diverse to provide component categories here; it encompasses all the disciplines found in the sciences and engineering. A partial list may be found in Appendix 2.
Administration	1. Training 2. Weapons Effects 3. Technology Transfer 4. Logistics/Combat Service Support • Material Acquisition, Storage, Movement, Distribution, Maintenance, Disposition • Personnel Movement, Evacuation and Hospitalization • Facilities • Services 5. New Systems and Concepts

APPENDIX 5

APPENDIX 5

OUTLINE FOR AN R&D OBJECTIVE STATEMENT

1. Definition of Mission Area
2. Description of Mission Area
   a. Current Characteristics
   b. Direction of Current R&D Efforts
3. Threat Peculiar to Mission Area
4. Policy Implications Applicable to Mission Area
5. Constraints Peculiar to Mission Area
6. Objective Elements

APPENDIX 6

APPENDIX 6

APPROVED AND PROPOSED AREA COORDINATING PAPERS (ACPs)[1]

Air to Ground Munitions
Space Communications
Ocean Surveillance
Combat Search and Rescue
Fire Support
Fleet Air Defense
Defense Suppression
Logistics (Transportation)
Aerial Targets
Continental Air Defense
Air to Surface Attacks in Conventional Air Warfare
Down Range Ballistic Missile Intelligence Collection
Tactical Air Command & Control
Battlefield Surveillance
Close Combat
Electro-Optical Warfare
Tactical Warning & Attack Assessment
Air Superiority
Fleet Anti-Submarine Warfare
Fleet Offensive Warfare
Field Army Air Defense
Strategic Bomber Pre-Launch Survivability
Land Missile Survivability
Strategic Aircraft Penetration
General War Communications
Navigation
Allocation of Resources for Electronic Intelligence (ELINT)
Avionics
High Energy Lasers
Ocean Surveillance (SURFACE)
Classified Title
Remotely Piloted Vehicles
Strategic Offensive Forces
National Value & National Command Authority Defense
Tactical Communications
Secure Voice
Tactical Nuclear Weapons Systems
Mine Warfare
Environmental Pollution Control
Mixed Tactical Jamming Force

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1 "Fiscal Year 1974 Authorization for Military Procurement, Research and Development, Construction Authorization for the Safeguard ABM, and Active Duty and Selected Reserve Strengths," Hearings Before the Committee on Armed Services, United States Senate, Ninety-Third Congress, Part 2, Authorizations, p. 1013 (10 April-1 May 1973).

Appendix E

RDT&E CONSTRAINING FACTORS

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Appendix E

RDT&E CONSTRAINING FACTORS

Defense RDT&E objectives, no matter how well conceived, must be compatible not only with defense guidelines and national defense policies but also with fiscal, manpower, and other constraining factors that exist inside and outside the defense establishment. This section will address itself to those factors that may constrain the development of RDT&E objectives and the plans for their achievement.

1. Fiscal and Budgetary

A dominant factor in the integration of RDT&E into the national security planning process is the consideration of the fiscal resources to be assigned to the program. Of late, the reordering of domestic priorities has resulted in a general decline in funding for R&D programs as the domestic sector of the economy has been accorded priority concern. In terms of constant dollars, the decrease in RDT&E expenditures as a percent of GNP from FY68 to FY74 amounted to twenty-two percent. (See Figure 1.) If not reversed, this trend could have a serious impact on the planning flexibility of national security strategists, since cutbacks in defense RDT&E expenditures usually impact the introduction into service of advanced weapons which in turn can modify future force posture projections.

Fiscal constraints are imposed annually on the RDT&E program by Congress as it processes the Department of Defense request for funds. Cuts from the request are not uncommon in both the authorization and appropriation bills by House and Senate. The Armed Services and Appropriation Committees of both elements of Congress are active in exercising continuous control over the RDT&E program. Since the activity of either authorizing or appropriating funds for RDT&E is virtually a continuous process, the possibility is that one or more programs considered key by the Administration

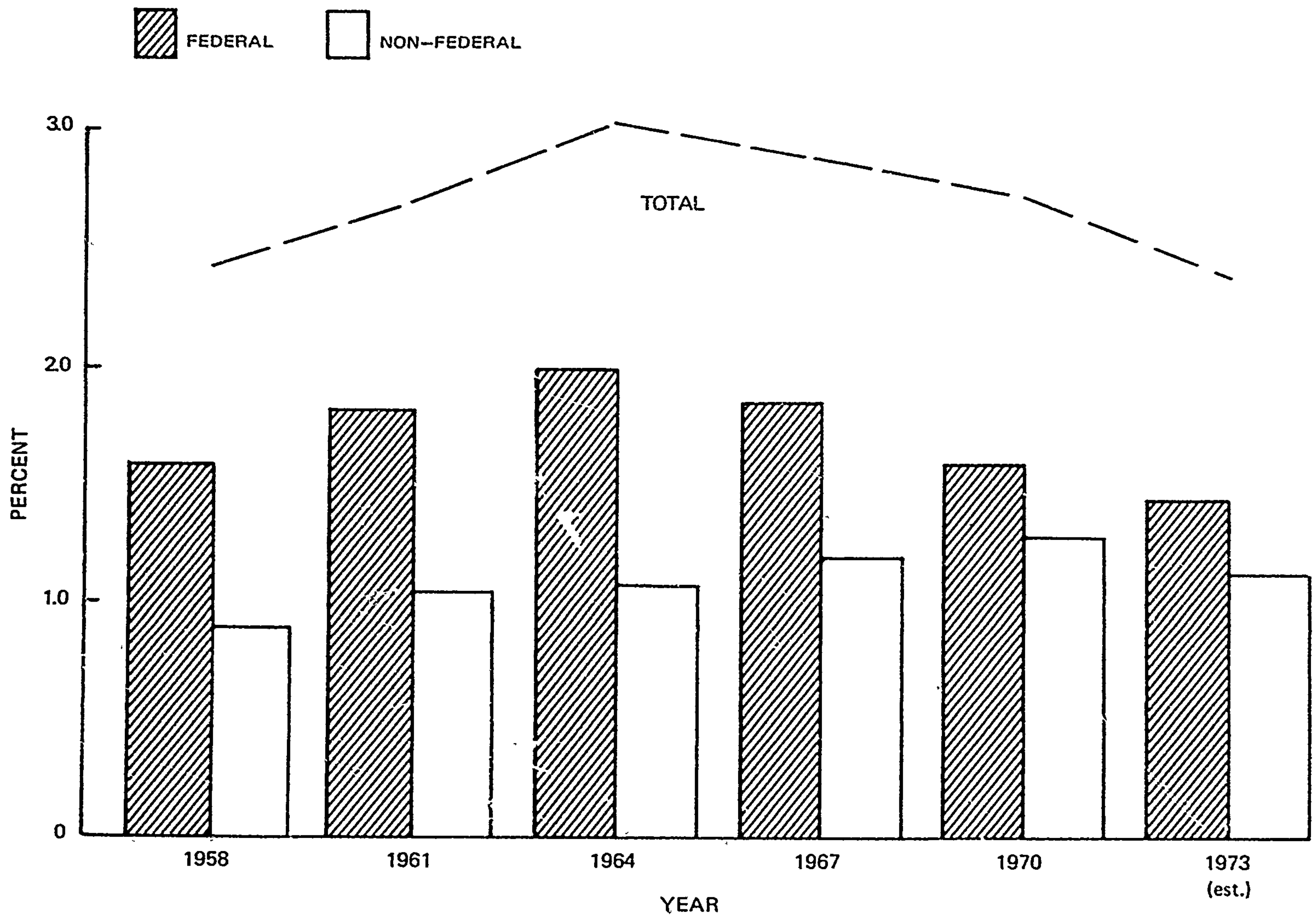

Figure 1 R&D/GNP. 1958–73

Source: National Science Foundation.

may be eliminated from the budget or seriously constrained in either timing or complexity or both. The uncertainties occasioned by the annual Congressional process pose a major problem in integrating RDT&E into national security planning.

Fiscal constraints on the defense R&D program begin within the PPBS cycle. After the JSOP is submitted, it is reviewed by the President, the National Security Council and the Secretary of Defense. At this time, tentative fiscal guidance is given JCS and the services. This guidance informs them of the amount of money that they can expect to receive in the fiscal year being considered. Shortly after the publication of JSOP Volume II (which does not consider fiscal constraints), the Secretary of Defense publishes his final fiscal g[illegible]nce. This gives total DOD and service budget figures that cannot be e[illegible]ded.

Based on this fiscal guidance, JCS revises the force levels to bring them in line with the fiscal guidance. The services finally submit their budget estimates, which are reviewed by OSD and OMB, and budget decisions are made by the Secretary of Defense. Then the President's budget is put together.

2. Manpower

A recent report prepared by the National Science Foundation notes that the number of scientists and engineers employed in the R&D field is declining in both absolute numbers and as a percentage of the population. (See Figure 2.) This overall trend reflects in part the fall off in funding for RDT&E experienced throughout the defense industry since 1969 and resulting manpower reductions; the number of scientists and engineers employed by the Department of Defense has, however, remained fairly constant.

The Office of Education has projected that, on the basis of trends in the past 10 years, the number of bachelor's degrees in engineering will be likely to average about 46,000 per year between 1970 and 1980, very close to the demand projection (48,000 see below) which suggests a further

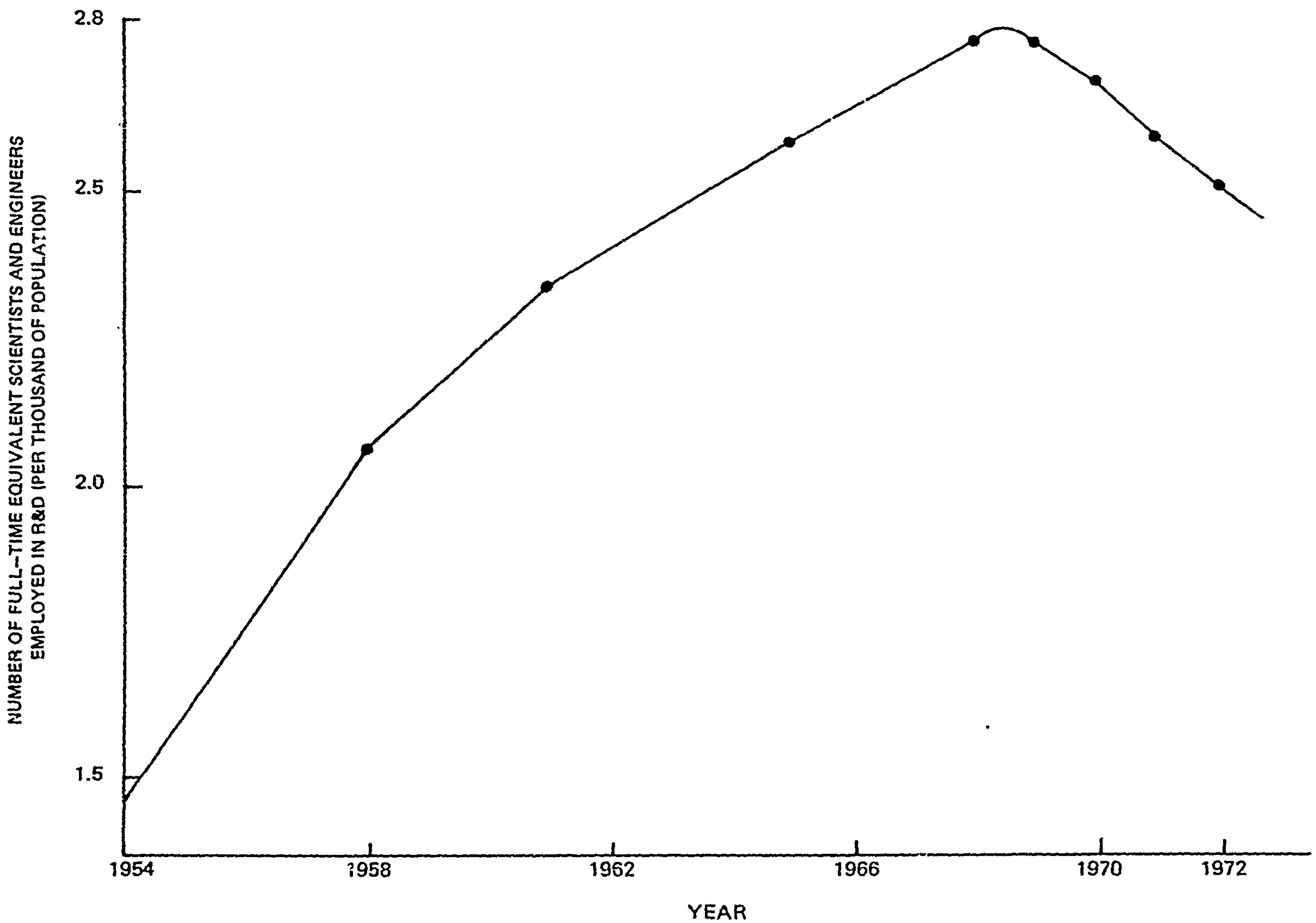

Figure 2 NUMBER OF FULL-TIME EQUIVALENT SCIENTISTS AND ENGINEERS EMPLOYED IN R&D

Source: National Science Foundation.

determination of the defense RDT&E manpower base since the current trend among young graduates is to seek career opportunities in the nondefense sector of the economy. But an NSF study expects a sizeable oversupply of engineers with doctorates in 1980, and the Manpower Report of the President in 1972 suggested that moderation be followed in expanding Ph.D. programs not only in engineering but also in the sciences.

Generally, the overall unemployment rates have remained relatively low, indicating a rather tight market. However, in the first part of calendar year 1971, the unemployment rate for engineers was 3.0 percent (up from 0.7 in 1968) and 2.6 percent for scientists. Further, the unemployment rate for engineers in defense-related work was 4.8 percent at that time. By 1972, the overall unemployment rate for engineers had dropped back to 1.9 percent, and at the present time (early 1974) it is down to 0.6 percent--the lowest it has ever been.

The Department of Labor has projected that the requirements for engineers and scientists will be two-fifths higher in 1980 than in 1970. That projection assumes overall economic growth rates high enough to provide full employment. This growth would require about 48,000 engineering graduates per year during the 1970-80 decade.

Thus, it would appear that, unless expenditures for RDT&E are greatly expanded, demand and supply would more or less equal out. However, the recent emphasis on energy research has already taken up the slack in unemployment among engineers, as the present 0.6 unemployment rate.

3. Materials

The availability of materials is not a direct constraint on R&D because the amounts used for R&D alone are relatively small. Material shortages, however, are a constraint at the production stage and thus R&D is constrained indirectly.

There are a number of concerns here. One relates to nonrenewable resources that are in short supply (compared to continued and increasing demand), another relates to required resources that are not controlled by the United States (or our allies), and yet another relates to resources controlled by a few countries (not including the United States). The problems encompass both supply and price.

With reference to the first concern, testimony before the Joint Committee on Defense Production pointed out that there is an ever-increasing competition for raw materials in world markets, that easily accessible high-grade ore deposits either have been or are being exhausted, that the level of activity and results of the present exploration program for metals and ores have been disappointing, that the development of reserves is declining for a wide range of materials, and that technology has not been developed to lower costs and increase available supply from marginal and submarginal resources. Testimony also indicated that the trend for a growing number of primary minerals is toward higher costs; there is a leveling off of domestic production and a heavier recourse to substitutes.

With reference to the second and third concerns, the National Commission on Materials Policy, as a result of a study of U.S. demand of natural resources compared to supply up to the year 2000, concluded that "in the case of a majority of our basic materials, the gap between our requirements and the remaining easily accessible world supplies is widening."[1] In this connection, Figure 3 lists minerals, the percentage of these minerals imported into the United States in 1972, and the major foreign sources of these imported minerals. Table 1 shows the extent to which the United States is expected to be dependent on foreign sources for 13 basic industrial raw materials in 1985 and the year 2000.

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[1] National Commission on Materials Policy, "Towards a National Materials Policy," Washington, D.C., April 1972.

MINERAL	MAJOR FOREIGN SOURCES
PLATINUM GROUP METALS	UK, USSR, SOUTH AFRICA, CANADA, JAPAN, NORWAY
MICA (sheet)	INDIA, BRAZIL, MALAGASY
CHROMIUM	USSR, SOUTH AFRICA, TURKEY
STRONTIUM	MEXICO, SPAIN
COBALT	ZAIRE, BELGIUM, LUXEMBOURG, FINLAND, CANADA, NORWAY
TANTALUM	NIGERIA, CANADA, ZAIRE
ALUMINUM (ores & metal)	JAMAICA, SURINAM, CANADA, AUSTRALIA
MANGANESE	BRAZIL, GABON, SOUTH AFRICA, ZAIRE
FLUORINE	MEXICO, SPAIN, ITALY, SOUTH AFRICA
TITANIUM (rutile)	AUSTRALIA
ASBESTOS	CANADA, SOUTH AFRICA
TIN	MALAYSIA, THAILAND, BOLIVIA
BISMUTH	MEXICO, JAPAN, PERU, UK, KOREA
NICKEL	CANADA, NORWAY
COLUMBIUM	BRAZIL, NIGERIA, MALAGASY, THAILAND
ANTIMONY	SOUTH AFRICA, MEXICO, UK, BOLIVIA
GOLD	CANADA, SWITZERLAND, USSR
POTASSIUM	CANADA
MERCURY	CANADA, MEXICO
ZINC	CANADA, MEXICO, PERU
SILVER	CANADA, PERU, MEXICO, HONDURAS, AUSTRALIA
BARIUM	PERU, IRELAND, MEXICO, GREECE
GYPSUM	CANADA, MEXICO, JAMAICA
SELENIUM	CANADA, JAPAN, MEXICO, UK
TELLURIUM	PERU, CANADA
VANADIUM	SOUTH AFRICA, CHILE, USSR
PETROLEUM (inc. Nat. Gas liq.)	CENTRAL & SOUTH AMERICA, CANADA MIDDLE EAST
IRON	CANADA, VENEZUELA, JAPAN, COMMON MARKET (EEC)
LEAD	CANADA, AUSTRALIA, PERU, MEXICO
CADMIUM	MEXICO, AUSTRALIA, BELGIUM. LUXEMBOURG, CANADA, PERU
COPPER	CANADA, PERU, CHILE
TITANIUM (ilmenite)	CANADA, AUSTRALIA
RARE EARTHS	AUSTRALIA, MALAYSIA, INDIA
PUMICE	GREECE, ITALY
SALT	CANADA, MEXICO, BAHAMAS
CEMENT	CANADA, BAHAMAS, NORWAY
MAGNESIUM (nonmetallic)	GREECE, IRELAND
NATURAL GAS	CANADA
RHENIUM	WEST GERMANY, FRANCE
STONE	CANADA, MEXICO, ITALY, PORTUGAL

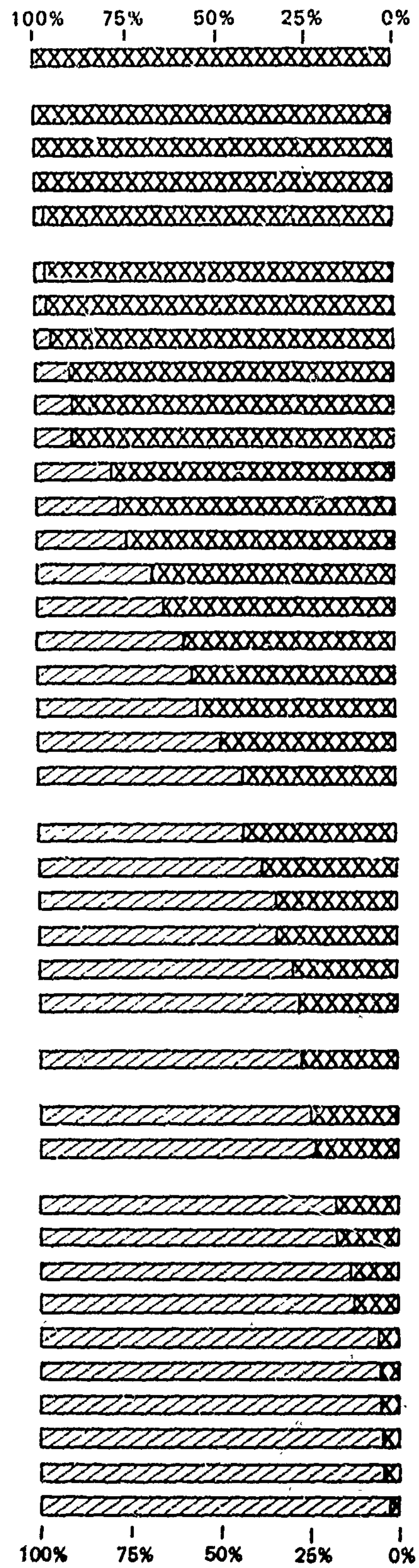

Figure 3 IMPORTS SUPPLIED SIGNIFICANT PERCENTAGES OF TOTAL U.S. DEMAND IN 1972

Source: U.S. Department of the Interior, "Mining and Minerals Policy," 1973.

Table 1

U.S. Dependence on External Supplies of Principal Industrial Raw Materials: 1950 and 1970 With Projection for 1985 and 2000

Raw Material	1970	1985	2000
	percent imported		
Aluminum	85	96	98
Chromium	100	100	100
Copper	0	34	56
Iron	30	55	67
Lead	31	62	67
Manganese	95	100	100
Nickel	90	88	89
Phosphate	0	0	2
Potassium	42	47	61
Sulfur	0	28	52
Tin	n.a.	100	100
Tungsten	50	87	97
Zinc	59	72	84

Source: L.R. Brown, "The Interdependence of Nations," Foreign Policy Association, New York, October 1972.

The United States and other industrialized countries are, at the present time, still highly dependent on iron and the main alloying metals of manganese, chromium, nickel, molybdenum, tungsten, cobalt, and vanadium. As Table 1 indicates, by 1985, the United States will be dependent on foreign sources for most of these materials. No material in use at the present time rivals the range of qualities available in steels, but this is now changing as aluminum, magnesium, composites, and plastics have come into mass production.[1] (For example, at very high temperatures, in aerospace and supersonic aircraft work, where atmospheric reentry heats go beyond the melting point of most steels, they have been superseded by ceramic refractory coatings and refractory alloys of other materials.)

The strong alloys of aluminum now provide many of the physical qualities of steel at less than one-third its weight. Although there is more aluminum available in the earth's crust than iron, extraction of aluminum from bauxite requires large amounts of electrical power, so that this material is developed in areas where the two coexist. (Aluminum alloys have paced the development of aircraft and aerospace technologies). With the exception of Canada and the USSR, most major users of aluminum are more or less dependent on imported bauxite.

The relative importance of tin as a "strategic" metal lies in alloying. Important deposits of tin ores occur in only a few parts of the world. Titanium has now reached volume production as a major structural metal with very high strength-to-weight ratios that outperform columbium and magnesium alloys for many purposes. For example, in 1965, the latest Mach 3 aircraft was one of the first all-titanium aircraft. Imports of rutile, the basic raw material for titanium metal, have increased sharply. The majority of our supply of this material comes from Australia.

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[1] J. McHale, The Ecological Context, p. 140 (George Braziller, New York, 1970).

Development of atomic weapons and other nuclear energy uses have made uranium, radium, thorium, and plutonium extremely important metals. However, estimates of uranium and thorium reserves in the United States alone are hundreds of thousands of times greater than the initial supply of fossil fuels.

The recent actions of the Arab countries in raising the price of oil and withholding oil from the United States and our allies have not been lost on the developing countries of the world. The special U.N. session of April 1974 was called to consider, among other issues, the world raw material situation, with an emphasis on assuring adequate prices for the producing countries. One of the recommendations was that producers of raw materials form cartel-like associations to control prices. This, of course, is a distinct possibility when a few countries control most of the exportable supplies of a material. There are many examples of such situations. One such example is that three countries--Malaysia, Bolivia, and Thailand--account for 70 percent of all tin entering international trade channels.[1]

According to John McHale, the industrial world is entering another phase of development which is characterized by the possible displacement of steel as the prime industrial material by other metals, composite materials, and plastics.[2] Thus, new materials development and discovery can alter the outlook for the future.

4. Domestic Science Policy

Although hearings were held in the U.S. House of Representatives in 1970 to explore whether or not there should be a structured national science policy and, if so, what this policy should be, as of 1974, there still is no officially stated U.S. science policy. Dr. Lee A. DuBridge, as head of the Office of Science and Technology (OST) in the White House, testified in 1970 that the lack of U.S. policy had become critical, that

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[1] L. R. Brown, "Globe Gobbling: The World Scarcities Ahead," Washington Post, p. C-3 (25 November 1973).

[2] McHale, op. cit.

such policy could furnish guidelines and serve to coordinate science in the many government agencies. He further testified that his office did not have the funds to pursue the development of a science policy, and that he believed that the Bureau of the Budget (now OMB) in effect had the dominant role in determining policy.

When OST was abolished in January 1973, the role of science advisor was transferred to H. G. Stever, Director of the National Science Foundation. At this time, it was also announced that an Office of Science Policy would be established within the Director's office at NSF.

Although there is no formally stated U.S. science policy, there may still be constraints on defense R&D as the result of an implicit policy for science. This implicit policy can take the form of federal budget decisions relating to R&D funds for the various government agencies, the portion of R&D funds that is spent for basic research, and the amounts that may be allowed for graduate study for scientists and engineers. Other implicit policy constraints may be the result of the government organization for scientific activity.

In the case of the federal government, at least, there can be, and in fact is, spillover of research findings--particularly basic research--from one agency to another. Thus, for example, if the total federal government budget for research is cut, this could have an adverse effect on defense R&D. Table 2 shows that total federal R&D expressed in constant dollars has decreased from $9.6 billion in FY68 to $7.7 billion in FY74, although funds for basic research held constant at about $1.1 to $1.2 billion during the same time period. The last column shows that basic research, as a percent of total federal R&D, has increased slightly, but this is due to the decreasing total expenditures for federal R&D. Dr. Philip Handler, President of the National Academy of Sciences, is one of many scientists who are concerned about the eroding base of scientific endeavor in the United States. He testified in May 1973 that the AEC was finding it increasingly difficult to contribute its support to nuclear physics, that the NIH had been forced

Table 2

FEDERAL OBLIGATIONS FOR R&D
($ billions)

FY	Total	1958 $	Basic	1958 $	Basic as % of Total
1968	$15.921	$9.6	$2.056	$1.2	12.9%
1969	15.641	9.0	2.077	1.2	13.3
1970	15.340	8.3	2.042	1.1	13.3
1971	15.564	7.9	2.132	1.1	13.7
1972	16.553	8.0	2.411	1.2	14.6
1973 est	16.966	7.9	2.475	1.2	14.6
1974 est	17.383	7.7	2.421	1.1	13.9

SOURCE: NSF, Science Resource Studies Highlights NSF 73-312, 17 Aug. 1973.

to discontinue its support of research in organic chemistry, and that the amount of money in biomedical research was being reduced. Research in all these fields has application to defense and thus presents concerns for DOD.[1]

In the matter of federal support for scientific study, between 1971 and 1973 there was an overall decrease in NSF funding for science education--particularly of the undergraduate level. Also, postdoctoral fellowships and training grants are being phased out, both at NSF and NIH. Part of the reduction in funds for graduate student support was the result of OMB impoundment. Part is the result of a basic policy decision to de-emphasize the role of science education in NSF programming.[2]

At the present time, NSF has some responsibility for coordination of federal research efforts. However, in practice, it has been questioned whether an agency that is on the same level as other agencies and with a smaller budget than many of the other agencies can perform this function. Many proposals for coordination at a higher level have been put forth. Although the present administration has obviously not been receptive to these suggestions, there is evidence that Congress is interested in reorganizing the U.S. science establishment.[3] For example, the National Science Policy and Priorities Act of 1973 (S. 32) would increase the mandate and the funds for NSF, although its focus would still be directed toward civilian science and technology. (This legislation is still pending.) Other proposals have called for a cabinet office for science and technology, or expanding NASA into a civilian technology agency.

5. Political Considerations--Allied and Adversary

There are a number of political considerations that can constrain defense R&D. They may be the result of attitudes expressed by our allies,

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1 U.S. Senate Hearings Before the Special Subcommittee on the National Science Foundation of the Committee on Labor and Public Welfare, pp. 115-116 (3 May 1973).

2 *Ibid.*, pp. 146-147.

3 U.S. Senate, S. 32 (4 January 1973).

our adversaries, the Third World, the American public, or a combination of these. One example of R&D constraints as a result of political considerations involves those that came out of Project CAMELOT some years ago. As a result of this outcry, DOD policy criteria were revised to limit social science research overseas to cases where: (1) there are substantial U.S. military forces in the country at the time of the study, or (2) work is requested by U.S. military officials in the country and by the host government, or (3) the study deals only with U.S. personnel serving overseas. Further, projects must now be cleared by the U.S. Ambassador to the country involved, by the Assistant Secretary of Defense (International Security Affairs), and by the Foreign Affairs Research Council connected to the State Department's Bureau of Intelligence and Research.[1]

Of course, often when there is a concurrence among countries about the inadvisability of certain activities, treaties or interntional agreements are signed restricting those activities. These are discussed below.

6. Treaties, International Agreements, and U.S. Legislation

This section deals with major treaties, international agreements, and U.S. legislation that constrain defense R&D.

Limited Test Ban Treaty of 1963

The Limited Test Ban Treaty of 1963 prohibits nuclear test explosions in the atmosphere, outer space, or under water. The major domestic effect of the treaty has been to limit the kinds of yields that may be tested on nuclear weapons and limit the operational testing of certain weapons, such as the ABM system. The treaty in effect requires the United States to determine the feasibility of the ABM from information derived from underground tests, simulations, or from data received from atmospheric tests that predated the treaty. This increases testing costs and prevents the government

[1] U.S. Senate, DOD Appropriations FY70, Part I, p. 414.

from acquiring the best data for making decisions--that of actual performance testing.

The Seabed Arms Control Treaty

The Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Seabed and the Ocean Floor and in the Subsoil of April 1972 prohibits placing structures on those areas that are specifically designed for testing, storing, or using the weapons. The prohibition against testing facilities takes this whole area, with the exception of the seabed beneath the territorial waters of the coastal states and a 12-mile zone from the coastal states, out of the realm of possible weapons experimentation in peacetime.

The National Environmental Policy Act of 1969

The National Environmental Policy Act of 1969 requires all federal agencies to consider values of environmental preservation in their spheres of activity. The Act set up procedures to be followed, and established strict standards of compliance. DOD requires statements of compliance when the environmental consequences are or may be controversial. The AEC must submit environmental impact statements for its nuclear testing (as well as for its other programs).

Restrictions on Chemical Warfare R&D

Congress, through PL 91-121 and PL 91-441, took actions to restrict the testing of chemical warfare agents. While these laws do not prohibit testing, they are constraining in that they do not allow expenditures for operational air testing of lethal agents in U.S. territory or possessions unless the Secretary of Defense determines that such action is necessary in the interests of national security. These laws also preclude expenditures for future testing development of lethal agents outside the United States if the Secretary of State determines that such action

would violate international law. The President can only revoke these provisions in case of a national emergency.

Restrictions on Biological Warfare R&D

The United States is one of 110 countries that have signed an international agreement to limit the use of biological agents. Although 34 nations have ratified this agreement, the United States, the USSR, and the United Kingdom have not yet done so. This agreement, termed the "Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons, and on their Destruction," was opened for signature on 10 April 1972. The parties to this convention, if ratified by the United States, USSR, and U.K., would agree not to develop, produce, stockpile, acquire or retain biological agents or toxins that are for nonpeaceful purposes. The agreement also prohibits weapons, equipment, and means of delivery designed to use these agents or toxins for hostile purposes.[1]

In 1970 the United States stated that it would destroy its existing stocks of biological and toxin weapons and confine its programs to strictly defensive purposes. As a result, some BW facilities have been phased out and been replaced by other types of research.

SALT I

The SALT I Agreement of 1972 prohibits development and testing of ABM systems or components that are sea-based, air-based, space-based or mobile land-based. The testing of other systems, such as air defense systems, or their components to perform an ABM role is also prohibited. Development and testing of ABM launchers to launch more than one ABM interceptor missile at a time from each launcher and the development and testing of automatic or

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1 U.S. Senate, "Convention on the Prohibition of Bacteriological and Toxin Weapons," Executive Q, GPO, Washington, D.C. (1972).

semiautomatic or other similar systems for rapid reload of ABM launchers is also prohibited. The United States and the USSR also agreed that the number of test launchers for ICBMs and SLBMs should not be increased significantly above the current number.[1]

SALT II

Since the May 1972 SALT I accords between the United States and the Soviet Union, further attempts at arms limitations have occurred. In early June 1974 the announcement was made to seek a ten-year interim agreement to replace the 1972 SALT I accords and to include in these negotiations discussions on limiting missiles with multiple nuclear warheads. Thus at a meeting which began on 23 November 1974 President Ford and Leonid I. Brezhnev reached the new ten-year accord limiting missiles with multiple warheads to about 1,320 for both sides, and placing an overall delivery-vehicle ceiling for both sides of 2,400. Provisions carried over from the 1972 agreement were: a sublimit of 300 for the heavy Soviet land-based missiles, the SS-9 or the SS-18 when it is deployed; no new silos to be built; and no increase in the size of existing silos beyond 15 percent in total volume.[2] The agreement was worked out only after the Soviets agreed to exempt from the new agreement U.S. jet fighter-bombers based in and around Europe that could reach Russia with nuclear weapons. The question of mobile ICBMs was left open.

Officials favoring the agreement say that this agreement permits the United States to continue its ongoing weapons programs (such as Trident, the B-1, and the next generation nuclear submarine). However, because of the high levels of MIRV-equipped missiles to be allowed each side (there are no restrictions on the actual number of individual MIRV warheads) it is expected that the Ford Administration will face extensive questioning on the proposed

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1 U.S. Senate, "The Arms Treaty and Interim Agreement and Associated Protocol," 92nd Congress, 2d Session, Executive L, GPO, Washington (1972).

2 L. H. Gelb, New York Times, p. 1 (3 December 1974).

agreement before Congress.[1] Despite the high MIRV levels it has been reported that the Ford Administration believes the accord to be a significant breakthrough in negotiations with the Russians and it is also believed that if the follow-up negotiations are successful a new agreement next year will "cap" the arms race for the next ten years.[2]

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1 M. Getler and M. Marder, Washington Post, p. 12 (26 November 1974).

2 Ibid.

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